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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XIV.—NO. 333.

UNDERGROUND WIRES.

THE remarks of Mr. Downs, the general manager of the New England Telephone Company, which we published in our last issue, relate to actual facts, and are, therefore, of considerable value. The results are only what any electrician, who really knows the science of his profession, might have predicted. The amount of nonsense which has been talked with reference to the cure of "induction" in telephone wires is astonishing. That this should be the case is no doubt greatly due to the fact that a very great number of the electricians of the present day have acquired the knowledge which they possess from the experience of but one or two years, and that in a school of training in which only practical experience without elementary facts can be learnt. In other words, they have received their education under engineers who have never learnt the elements of their profession. That electro-magnetic induction and inductive retardation are two different effects, does not appear to have struck them; the two both come under the name of "induction" simply, and therefore it seems to be assumed that any method that will cure the one difficulty will necessarily cure the other. Mr. Lockwood says :—"It is true that from 800 to 1,200 patents for systems claiming to overcome the difficulty have been granted; but it is also true that the inventors do not know what the trouble is. They work with the idea of securing insulation, but that is the least of the difficulties."

In the report in question it is stated that "two miles is the limit for work on underground telephone wires." This may possibly be the case in the particular form of cable on which the experiments were tried. As a matter of fact, at the present time, lengths of over fifteen miles are in daily use with the Gower-Bell telephone in the telephone system of the Postal Telegraph department, the wire being a No. 20 copper, covered to No. 11 with gutta percha. The actual length which it is possible to work through is really principally a matter of the relative diameters of the insulating covering and the conductor, that is to say, it is a matter of the electrostatic capacity of the wire. It has been often stated that the capacity of certain insulated cables is remarkably low, and that, consequently, they must be well adapted for long distance working. We believe, in fact we know from actual experience, that this idea has in many cases resulted from an incorrect appreciation of the actual conditions under which the capacity test is made. Low insulation, it is noticed, is, to a certain extent, synonymous with low capacity. The usual method of testing capacity is to charge the cable or insulated wire and then to measure the discharge; if the latter is low, it is at once assumed that the capacity is low. The experimenters seem to forget, however, that unless the insulation resistance of a wire is extremely high, the charge which may be taken up is lost with such extreme rapidity by leakage, that the amount which discharges from the extremity of the wire at which the "discharge key" is connected may be really only a mere fraction of what the wire actually contained; in fact, if the "battery" and "galvanometer" contacts of the key are comparatively wide apart, the whole, or nearly the whole, of the charge may have disappeared during the short interval occupied by the lever of the key in passing from the charging to the discharging contact. Short as this interval may be, however, it may be enormously greater than the time occupied by each electrical vibration set up in the wire by the action of the telephone transmitter, and which would practically be limited in its rapidity by the actual capacity of the wire, a capacity which is represented by full charge, and which it is actually impossible to measure by any known method.

The use of double wires effectually cures the evils of electro-magnetic induction between wire and wire; such an arrangement is possibly a little more costly than would be some device to effect the same result on a single wire, but up to the present every one of the methods which have been tried to get rid of induction by other means than by the double wire system, have practically utterly failed. In the vast majority of cases the devices suggested and patented have really only served to prove that the inventors are ignorant of elementary principles. In cases where the methods have been partially successful, it has been at the expense of loud articulation; in fact, the diminution of induction has been exactly in proportion to the diminution of power in the telephone receiver.

Working through long distances of underground wire is by no means impossible, in fact it can be effected at any time; the question is purely one of expense. It is only necessary to increase the thickness of the dielectric sufficiently, and we can practically work as far as we like, but with the insulating materials at present in general use, such an arrangement is out of the question on the score of expense. If, however, some cheap and reliable insulating material of low specific inductive capacity be discovered, the distance over which underground telephony and fast-speed telegraphy could be extended would be considerable.

OUR GUTTA PERCHA SUPPLY.

A SUBJECT of great interest has been broached in the report on the origin and acclimatisation of gutta percha, contained in the *Annales Telégraphiques*, for September-October and November-December of last year, which we have recently received.*

There can be no doubt that the question as to the continuance of the supply of gutta percha deserves very serious consideration, as, up to the present time no other body or compound has been found which can supersede it, in the field in which it plays so important a part.

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* Rapport à Monsieur le Ministre des Postes et des Télégraphes, sur les Origines de la Gutta Percha et sur la possibilité de l'acclimater dans la Cochinchine Française, par M. Seligmann-Lui, Sous-Ingénieur des télégraphes.

By this report we find that in the liberal spirit which has always distinguished the present Minister of Posts and Telegraphs in France, Mr. Seligmann-Lui, one of the French telegraph staff was sent to the Straits Settlements to gain as much information as possible concerning the various kinds of gutta percha and India rubber plants in that district. The object of this visit was to enable him to carry out an examination in the French colony in Cochin China to determine whether the above mentioned plants were indigenous to the colony, and if not, to advise on the feasibility of planting them there.

In the first part of the report, we do not find much light thrown on the subject, indeed rather otherwise. We can hardly be surprised at this, considering the many difficulties with which the author had to contend before even coming in sight of a gutta percha tree. Indeed it is this very difficulty in finding the trees, that has created such a scarcity in the supply of this gum.

We notice that the author does not place much value on classing the different plants scientifically, but has assorted them according to their Malay names. In this manner he divides them into nine distinct species, but we do not think that this classification can be relied on, as, apart from the confusion due to local names, we notice some serious errors; thus, in Class 8, we find both *gutta-durriau* and *gutta-tabau*. Now these are two altogether distinct products and which, however they become coloured, during the process of boiling down, are respectively *gutta-puteh* (white gum), and *gutta-merah* (red gum.)

In his last class he mentions *kajou-arrou*, but the kajou-arra, although its sap may be used sometimes for adulterating the real gutta, is in itself a climbing plant, and cannot for a moment be confounded with a gutta tree, by anyone who has seen both.

We also find some mention of India rubber, but here also we observe some confusion. The *gutta-rambong* which is really from the *ficus-elastica*, he supposes to be identical with *gutta-susu* (Borneo rubber), whereas this latter is really obtained from the *urceola elastica*, which is not a tree, but a climbing plant; the gums from which are called variously *jintawau*, *jintawau-susu*, *jintawau-culat*, *serapit*, *menungau*, etc.

As regards the gutta (*gutta durriau*) which Mr. Seligmann-Lui mentions as the best, as a matter of fact the natives find a difficulty in getting this particular gum into the solid state, and for this purpose add to it a juice called *gutta jelutong*, obtained from a species of *alyxia*, and possibly it may derive the extra qualities he observed in it from the addition of this sap.

In the résumé at the conclusion of his report the writer appears to recommend strongly the establishment of gutta percha tree plantations in Pahang, an independent state on the east coast of the Malay Peninsula, as he finds that Cochin China does not hold out much promise of success. It is to this project that we would most strongly draw attention.

An undertaking of this class can only be adequately carried out by a government or some strong company, already established in a favourable locality, and to which the plantation of gutta trees might only form a subsidiary branch. When we point out the fact that at least 30 per cent. of the present market cost of the gutta percha is due to the time and labour expended by the collectors in searching for and finding the tree, and before it is even touched, the advantage of having these trees grouped together in a plantation is at once apparent. Apart from this important point, the manner in which the sap is collected by the natives is extremely wasteful, as the writer has also observed in his report.

Each tree being felled, the bark of the trunk and branches has annular incisions made in it at distances of about 3 feet apart, and the sap which then runs out is caught in rough troughs made out of leaves or bark. There is in these operations much loss from the juice being washed out of the receptacles by rain; besides this, the trees in the mountainous districts when felled sometimes have their bark so lacerated by falling among the sharp and rugged rocks that the sap escapes by the wounds and is lost.

All the above causes of loss, besides others on which we do not dwell at present, could be eliminated in large well-organised plantations, and, although it is never done, we believe that the sap could be obtained by tapping the tree without previously felling it. At present, no effective prohibition has ever, that we are aware, been placed on felling these trees, and as the immediate yield is greater and more conveniently obtained by cutting the tree down, one can hardly wonder that the quickest and easiest method is adopted by the natives. It is to be regretted that the author did not avail himself of his opportunity to set at rest the question as to whether the sap runs freely from the *tsonandræ* by simple tapping.

Taking into consideration the savings which could be effected in the manner sketched out above, together with the almost certain rise in the price of the gutta as it becomes more scarce, a strong position can be taken against the undeniable objection that about 25 years must elapse before the trees should be tapped.

The example of enterprise and foresight set by the French Minister of Posts and Telegraphs in moving in this matter will, we hope, not be lost on our own Government, as this appears to us an undertaking which cannot, or at any rate will not, be carried out by those who might naturally be expected to do so, namely, the native rajahs, and although most of the gutta producing area is under the protection of Holland, there is still a large expanse over which the English Government can make its influence felt for good.

THE ELECTRICAL RESISTANCE OF THE HUMAN BODY.*

By Dr. W. H. Stone.

In two previous communications last year I showed that the amount of this important basis of rational electro-therapeutics had been enormously overstated. Since then I find it given in the new edition of Rosenthal's "Elektricitätslehre," published in the current year, as about 5,000 ohms, and, to my surprise, so competent an observer as my friend Prof. Dolbear, in Lockwood's "Handbook of Electric Telegraphy," states it vaguely as from 6,000 to 10,000 ohms. On the other hand, Count Du Moncel, in his paper on the conductivity of imperfect conductors in the *Annales de Chémie et de Physique*, vol. x., 1877, approaches more nearly to the real value in stating it from wrist to wrist to vary from 350 to 220 kilometres. This is probably the Swiss unit given in Clark and Sabine's tables as equal to 10·42 ohms, or thereabouts. Both Rosenthal and Du Moncel furnish internal evidence that their excessive estimates were due to imperfect contact through the skin; for the former speaks of using 50 chromic acid elements of two volts E.M.F. each; whereas the current from this large battery, with proper contact, would be utterly unbearable to the patient, if not dangerous. The highest current I have seen employed was from 22 of these cells through less than 2,000 ohms resistance. It was done against my advice, and produced a large carbuncular boil at the nape of the neck, where the negative pole was applied. I have since then completely modified my method of making the skin contacts, and no similar accident has occurred.

Even with a far smaller current, namely, that of eight Daniell cells and small platinum electrodes, of which the size is accurately given, namely 4½ by 3 cm. (roughly, the length of two shillings side by side, and the breadth of a florin), Du Moncel produced a similar, though much more serious accident. The current was passed at intervals for an hour and a-half from wrist to wrist, the patient being a lady, and afterwards for shorter periods in the opposite direction. "On withdrawing the electrodes," says the writer, "to my great astonishment I found, on the parts of the wrists where my electrodes had been applied, very pronounced scars resembling burns produced by an acid or a caustic. These scars, to the number of three at the negative pole, were large and deep. At the positive pole they were very small, and 32 in number. During the first two days after the experiment no inflammation supervened, but on the third day it began about the negative scars, and it was necessary to have recourse to poultices, which were kept up for a month; even then the sloughs were not detached." It is satisfactory to find that no permanent harm was done; but it is evident that the excessive resistance recorded, amounting at times to 3,500 ohms, was mainly due to this cause. It is perhaps not to be wondered at that the scientific Count should have relinquished this branch of his investigation.

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* *Nature.*

With hands soaked in strong brine, and then enveloped in a thickness of flannel wetted with the same solution, bandaged surgically over this with a spiral strip of lead, at least 30 cm. long, and 5 cm. broad, no local accident has ever occurred to me, nor has any local pain been mentioned. But with 10 bichromate cells in good order, the shock felt at making and breaking circuit has often been considerable. Indeed, my tall and athletic clinical clerk, Mr. Shackel, who kindly consented to act as a resistance, noticed that, when being tested from foot to hand (in his case a length of 7 feet) with 1,027 ohms resistance, the opposite side of the body was jerked at these instants. In all recent experiments I have never exceeded this E.M.F., which is at the outside 20 volts, or about 18 volts as the cells run down.

In all cases hitherto named an ordinary battery current has been employed. In a paper read by me before the British Association at Southport, I named a rotating commutator, and also one on the plan of a metronome, which I had tried for the purpose of diminishing currents of polarisation by regular inversion. I preferred, however, the rapid manipulation of an ordinary commutating key with the fingers of the left hand until the "throw" of a damped galvanometer was all but extinguished.

At the Southport meeting, however, my friend Dr. Oliver Lodge suggested the use of alternating currents of induction, and a telephone in place of the galvanometer, and Prof. Lankester, the president of the section in which my paper was read, kindly suggested that I should apply to the Royal Society for a grant in aid to purchase the expensive apparatus required for these experiments. The latter suggestion I at once acted on, and met with unconditional refusal on a printed form. Being thus thrown on my own small means, I proceeded to act on the former suggestion, and ordered an induction apparatus of an excellent London maker. But the British workman, if sure, is decidedly slow, and the instrument, though stated to be in a condition of forwardness, is not yet ready. In the meanwhile, in the pages of the ELECTRICAL REVIEW for January 12, a diagram, description, and woodcut of a pretty little instrument, designed by Prof. Kohlrausch, of Wurzburg, for the measurement of fluid resistances, appeared; by his kindness I was put in communication with the firm of Hartmann and Co., of that town, the makers. They at once forwarded me the instrument, which proves to be beautifully made, and extremely moderate in price. This acknowledgment I owe to the Professor's courtesy towards a stranger, and their briskness in carrying out his wishes. Upon its details it is needless now to insist, it being practically a small induction-coil united to a metre-bridge of platinum-silver wire, with resistances of 1, 10, 100, and 1,000 ohms, to be intercalated in the divided circuit. It emits a steady buzz of about 120 vibrations per second, which is reproduced in the telephone by methods well understood. In my first experiments I found the original and the phantom buzz difficult to separate. The former is easily lessened by mounting the apparatus on vulcanised rubber tubing and a solid support. The R. is read off the scale by inspection: towards the left hand or middle of the wire with great accuracy; towards the right-hand end the ohms get squeezed together. When I drew the plug of the 1,000 R. my willing student-patient gave a jump out of his two brine baths and said he could not stand it. It was therefore necessary to use the 100 ohm plug. Even with this, however, the results were very remarkable. In this early period of my experiments two illustrative cases may be given. A female patient suffering from diabetes, but otherwise in good health, and able to walk about the ward, gave from foot to foot with an E.M.F. of 3·6 volts, a resistance of 1,210 ohms; from right hand to right foot, 1,350 ohms; and from left hand to left foot exactly the same figure. With the induction current she gave from foot to foot only 473 ohms; from hand to foot 735 ohms on the right, and 750 ohms on the left, side. The difference was so great, that at first I suspected instrumental error, but subsequent testings show that such is not the case. The discrepancy of 15 ohms between the two sides was clearly owing to my unfamiliarity with the telephone in place of galvanometer, and has materially lessened with greater experience.

A male patient suffering from dysentery, now perfectly well, gave from right hand to foot with a current of 3·6 volts a R. of 1,580, with 6·2 volts a mean of 1,510, with 18 volts a R. of 1,366. Each observation was taken twice; the first and last agreeing exactly, the intermediate only differing from 1,520 to 1,500. This is impossible at times to prevent from the unintentional motions of the patient slightly shifting the level of the brine baths. With the same baths and poles the induction current gave only 590 ohms resistance.

In neither of these cases was there any morbid condition of the muscles tested. The distance was in each case from the external malleolus of the foot to the head of the ulna in the corresponding hand. In recording these results, I prefer, as on the former occasion, to give them at once in their rough state before waiting for a plausible explanation, or endeavouring to procure a fallacious agreement between the two methods. What I stated then I now re-affirm, that there is some important difference of a physiological character between the human body as a conductor and ordinary fluid electrolytes.

No doubt, as Dr. Lodge suggests, "an alternating current ought to show too low a resistance, because of electro-chemical capacity, which it would treat like conductivity." But the difference is far too great for such an explanation, nor does it occur to this extent in saline solutions. I am at present engaged in testing its amount in physiological fluids, such as blood-serum, ascitic and ovarian effusion, and the like.

A beautiful metre-bridge on Prof. Kohlrausch's pattern, with platinum-silver wire of 3 m. long, has just reached me from Hartmann; with this I am using a "sledge" inductorium of Du Bois Reymond's with three different secondary coils of different lengths and fineness of wire. For the determination of the alternating currents passing I am using the small dynamometer with aluminium wire suspended coil, which was shown before the Physical Society, and briefly described in *Nature*.

This I shall check by a fine instrument now on its way from Wurzburg, with a single wire suspension and torsion head instead of the more sluggish bifilar method. Ultimately it may be necessary to use a quadrant electrometer.

Even at this stage it is obvious that the fact of the human body being about twice as permeable to induction as it is to low tension continuous currents is of great physiological and therapeutical importance.

Communication with South America.—The secretary of the West Coast of America Telegraph Company, Limited, intimates that telegraphic communication with Valparaiso, Buenos-Ayres, and all telegraph stations in Peru, Chili, the Argentine Republic, Uruguay, and Brazil, is now re-established *viâ* Galveston.

ON A METHOD OF DETERMINING THE MOST SUITABLE RESISTANCE FOR AN INSTRUMENT IN A COMPOUND CIRCUIT.

IF in any part of a compound electric circuit containing an electromotive force it is desired to insert an instrument, that instrument may have a certain resistance given to it, which will permit it to exert the greatest possible force. This resistance could be calculated in some cases, but in the majority of cases that occur in practice it could more easily be determined by experiment. Thus let it be required to insert an instrument of resistance, R, in a compound circuit, L, l, l, l, containing an electromotive force, E, and producing a current, A—

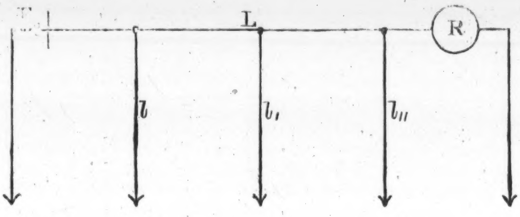

FIG. 1.

Then when RA^2 is made a maximum, R would be the most suitable resistance to give the instrument. It is therefore only necessary to insert in the circuit a rheostat, "R," and graduated galvanometer, m, of resistance, "g," and vary the resistance of the rheostat until the square of the deflection, multiplied by the resistance, $R + g$, is greatest. This rule follows from the law that the force exerted by a simple electro-magnet varies as the rate at which energy is expended in its coils; and the force exerted by an electro-magnet acting upon a magnet, varies as the square root of the rate that energy is expended in its coils.

This rule suggests a simple method, both of ascertaining the most suitable resistance for telegraphic instruments, and also for finding the limit of the distance that can be telegraphed over with a particular gauge of wire and kind of instrument.

On very short telegraphic lines on which there is no perceptible leakage, the rule for the resistance to be given to the instruments is that the sum of the resistance of all the instruments in circuit, should be equal to the remaining resistance of the circuit. But upon lines of from 100 to 150 miles, which necessarily have a considerable leakage, the resistance of the instruments must be much less than that of the remainder of the circuit. This resistance should be found, as before mentioned, by inserting a galvanometer and rheostat in the circuit, and adjusting the rheostat until the current square mutiplied by $(R + g)$ is a maximum; the resistance of the relay, plus that of the galvanometers at the home and distant station, should then be made equal to the resistance thus found.

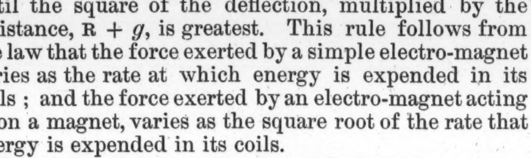

FIG. 2.

In the case of a duplex circuit, the resistance of the receiving instruments should be determined while the resistance of the home battery and the instruments of the distant station are in circuit; and it would be necessary to determine the resistance of R and R_1 at the same time. In fig. 2, L represents a looped line, the two sets of apparatus, A and B, being in the same office. Let R always equal R_1, and let R and R_1, have consecutively different values given them, w being balanced after such alteration of R and R_1, and thus determine what resistance must be inserted in R and R_1 to make $(\text{deflection})^2 \times (R + g)$ a maximum. The resistance of one of the sets of coils of (relay + galvanometer) would be made equal to $(R + g)$.

The distance that can be telegraphed over on a particular line, and with a particular description of instrument, is practically limited by the electromotive force that can be employed, since it is found in practice that a certain electromotive force cannot be exceeded with safety to the insulation of the line, so that if with the greatest safe electromotive force upon a number of circuits of different lengths, the maximum value of $A^2 (R + g)$ was obtained by adjusting R, it would be found that the value of $A^2 (R + g)$ would diminish with the lengths of the lines until it became too small for the instruments to respond to. That distance at which $A^2 (R + g)$ equalled the minimum expenditure of energy to which the instruments would respond would be the greatest length of line wire that could be used; and the resistance $(R + g)$ would be the resistance to which the receiving instruments should be wound.

The resistance $(R + g)$ should, of course, be divided between the instruments in the most suitable proportion. These values of the instruments' resistance should be found in bad weather.

W. MOON.

ALTERNATING CURRENT MACHINES.

THEORY AND PRACTICAL FORMULÆ OF ALTERNATING CURRENT MAGNETO-ELECTRIC MACHINES.

NOTE BY M. FELIX LUCAS, PRESENTED BY M. CORNU.*

THE moveable armature of an alternating current magneto-electric machine comprises $N = \mu\, v$ equal bobbins, and we group in quantity v groups of μ bobbins joined up in series; there are as many possible modes of grouping as there are manners of decomposing N into two entire factors, μ and v. The inductor is composed of fixed magnets.

For one mode of grouping we may first impart to the armature a fixed speed of rotation of n revolutions per minute. The effects obtained vary, then, with the resistance, R, of the conductor with which we close the circuit. Let I be the intensity of the electric current and T the motive work received by the machine and transformed by it into electrical energy; I and T are two functions of R. Let us designate, on the other hand, by r the resistance (measured, for instance, by means of a Wheatstone bridge) of the system of bobbins included in the circuit. We might express R and r in ohms, I in ampères, and T in horse-power. The principle of the conservation of energy gives first

$$(1.) \qquad (R + r)\, I^2 = 75\, g\, T.$$

In order to obtain a second equation, we may have recourse to experiment. I close the circuit by a conductor of unknown resistance; an electro-dynamometer shows the intensity, I, of the current; the pressure indicated by the manometer of the steam engine makes known the work which it produces and from which I subtract the work (measured beforehand) absorbed by the transmissions and by the movement of the machine when it runs with an open circuit: I thus obtain T. By varying the external resistance from zero to infinity, so as to obtain a great number of corresponding values, I and Γ, we obtain the elements of a graphic tracing in which we take I for the abscissa and T for the ordinate. I have recognised thus that the law according to which T depends on I, is represented by a parabola of the second degree which passes by the origin of the co-ordinates and of which the axis is vertical. We have, consequently,

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* *Comptes Rendus.*

$$(2.)\qquad o\,(\mathrm{I}-h)^2 = 75\,g\,(k-\mathrm{T}).$$

The numerical values of the three parameters, ρ (resistance), h (intensity), and k (mechanical work), are determined when required from the graphic; as the curve passes by the origin of the co-ordinates, we have—

$$(3.)\qquad \rho\,h^2 = 75\,g\,k.$$

If we eliminate T in the equations (1) and (2), taking into account the formula (3), and considering

$$(4.)\qquad \phi = \mathrm{Q}\,\rho\,h,$$

we find that there exists between R and I the very simple relation

$$(5.)\qquad (\mathrm{R} + r + \rho)\,\mathrm{I} = \phi.$$

The parameter, ϕ, is expressed in volts; as the electromotive force ρ represents a fictitious resistance, to which no consumption of mechanical work corresponds. The two equations, (1) and (5), contain all the laws of the function of the machine for a constant speed of the armature and for a fixed method of grouping.

If we wish to determine directly ϕ and ρ, we may make two accurate experiments, giving to the resistance, R, two known values, R′ and R″, and measuring the corresponding intensities, I′ and I″. We shall thus have

$$(6.)\qquad \begin{cases} \rho = \dfrac{\mathrm{R}''\,\mathrm{I}'' - \mathrm{R}'\,\mathrm{I}'}{\mathrm{I}' - \mathrm{I}''} - r, \\[2ex] \phi = (\mathrm{R}'' - \mathrm{R}')\,\dfrac{\mathrm{I}'\,\mathrm{I}''}{\mathrm{I}' - \mathrm{I}''}. \end{cases}$$

For variable speeds of the armature, ρ and ϕ become functions of the number, n, of revolutions per minute. By determining experimentally the nature of these functions, n varying from 150 to 850 revolutions, I have ascertained that they are linear. In other terms: The parameters, ρ and ϕ, increase in direct ratio to n. We have therefore—

$$(7.)\qquad \begin{cases} \phi = a + \propto n \\ \rho = b + \beta\,n \end{cases}$$

and the formula (5) becomes

$$(8.)\qquad \mathrm{I} = \frac{a + \propto n}{\mathrm{R} + r + b + \beta\,n};$$

I have verified this formula by a very great number of experiments.

We have now only to consider the mode of grouping of the machine, and experiment has led me to the following observations:—

The series grouping of μ identical systems multiplies by μ the parameters ρ, ϕ, and r; the grouping in quantity of v identical systems divides by v the parameters ρ and r, without modifying the parameter ϕ.

If, therefore, we designate by a_1, $\propto_1$, b_1, β_1 and r_1, the parameters coresponding to a single one of the bobbins, we shall have—

$$(9.)\qquad a = \frac{\mu}{v}\,a_1,\ \propto = \frac{\mu}{v}\propto_1,\ r = \frac{\mu}{v}\,r_1,\ b = \mu\,b_1,\ \beta = \mu\,\beta_1.$$

The electrical energy furnished by the machine on the external circuit is given by the formula

$$(10.)\qquad 75\,g\,\mathrm{T}_e = \frac{\mathrm{N}\,(a_1 + \propto_1 n)^2\,\mathrm{R}}{[v\,\mathrm{R} + \mu\,(r_1 + b_1 + \beta_1\,n)]^2}$$

It reaches the maximum when we conform to the relation

$$(11.)\qquad v\,\mathrm{R} = \mu\,(r_1 + b_1 + \beta_1\,n),$$

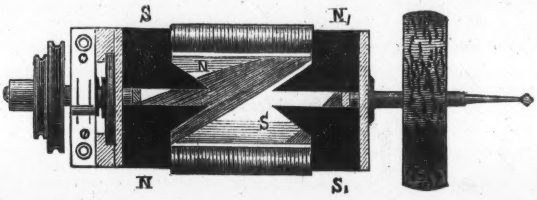
and its value is then

$$(12.)\qquad 75\,g\,\mathrm{T}_e = \frac{\mathrm{N}\,(a_1 + \propto_1 n)^2}{4\,(r_1 \times b_1 + \beta_1\,n)}.$$

My experiments, to obtain and verify these various formulæ, were made at the Dépôt Central des Phares, in December, January, and February last, with magneto-electric machines on the De Méritens system.

IRISH'S NEW ELECTRO-MOTOR.

THIS motor has been devised, we are informed, in consequence of the demand for small and effective portable motors. The illustration represents a convenient form for domestic and other uses, where small power only is required, and it is fitted with universal tool holder for brushes, emery wheels, drills, &c., also sheaves and friction wheel. Although a hand machine, it may be easily clamped to the bench or table. The field-magnets are simply electro-magnets, with their pole-pieces projecting inwards and hollowed to receive the armature. The ends of the magnets are coupled together by brass plates, which also form the bearings for the armature. The field-magnets are connected up so that their respective ends come together of different polarity. The armature is of simple Siemens' form, but with a twist, which brings one pole opposite N, N, the other pole opposite S, S. The machine is said to act well as a dynamo.



THE E.M.F. OF DYNAMO MACHINES, EXCITED BY A CONSTANT CURRENT.

[A COMMUNICATION.]

IT has been frequently assumed that the E.M.F. is constant for a uniform speed in dynamos, the field-magnets of which are excited by a constant current, and that the fall of potential at the brushes, consequent on increased current through the armature, is only due to the latter having some resistance.* For example, let a dynamo, the field-magnets of which are separately excited, give a difference of potential, V, at the brushes, when a current, C, flows through the circuit. If the resistance in the circuit is diminished, so that a larger curent, C_1, flows through the armature the potential at the brushes will be diminished to V_1 and on the assumption that the E.M.F. is constant

$$\mathrm{V} + \mathrm{C}\,r = \mathrm{V}_1 + \mathrm{C}_1 r$$

where r is the resistance of the armature

$$\mathrm{V} - \mathrm{V}_1 = r\,(\mathrm{C}_1 - \mathrm{C})$$

and

$$\mathrm{V}_1 = \mathrm{V} - r\,(\mathrm{C}_1 - \mathrm{C})$$

This means that the potential at the brushes is diminished by a quantity equal to the product of the additional current and resistance of the armature, and from this it might be expected that in any machine where r is very small, a considerable addition to the current might be made without diminishing to any great extent the potential at the brushes. Experiment shows that the actual fall of potential at the brushes is much greater than these formulæ would lead us to suppose; indeed, under certain circumstances, it is possible that the resistance of the armature is quite an unimportant factor in producing the result.

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* In connection with this subject I would draw the attention of your readers to an extract from an American paper, which appeared in the REVIEW for February 2nd, entitled "Regulation of Electromotive Force." In the article referred to Mr. F. B. Crocker ignores everything save the resistance of the armature.

To ascertain the exact way in which the potential at the brushes of a separately excited dynamo falls as the resistance in the circuit is varied, I have made a number of experiments, some of the results obtained being plotted out in the curves, figs. 1 and 2. The machines upon which I experimented were of the Pacinotti ring type, made by Messrs. Paterson and Cooper, the armature consisting of a number of thin discs of charcoal iron having teeth projecting from the body of the ring, between which the coils of wire were wound, the connections being as in the Gramme machine. The field-magnets were of soft cast iron, the pole-pieces enveloping the ring armature for about three-fourths of its circumference. The first machine upon which I experimented was a small shunt constructed to maintain 25 20-C.P. Swan lamps, and during the experiments the speed was maintained constant at 1,600 revolutions, the field-magnets being excited with a constant current of 1·8 ampère. Fig. 1 shows the results obtained with this machine, horizontal distances along, A, B, giving the current in ampères, and ordinates the difference of potential at the brushes. The resistance of the armature was ·12 ohm, and I have drawn a line, C, D, so that the tangent of the angle this line makes with the horizontal line, C, E, is equal to the resistance of the armature. If the formula given on the assumption that the E.M.F. is constant were true, the observed difference of potential at the brushes ought to fall on the line, C, D, but the great discrepancy between the observations and the line shows that the formula referred to but very inadequately expresses the relation between the potential at the brushes and the current flowing through the armature.

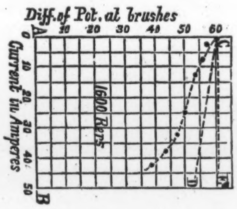

FIG. 1

Professors Ayrton and Perry have recently shown that the effect of self-induction due to starting and stopping the current in the coils of an armature as they pass the brushes, may be expressed as a resistance added to the armature, the value of which is equal to $\frac{\pi n L}{120}$ where n is the number of revolutions per minute, and L the co-efficient of self-induction per radian of the coil. For a fixed speed this resistance will be constant, but the E.M.F. required to overcome it will be simply proportional to the current. If we assume then that the E.M.F. of the machine is a constant, an additional quantity $= C\frac{\pi n L}{120}$ which represents the E.M.F. necessary to overcome the effect of self-induction must disappear at the brushes. Hence in a separately excited dynamo, running at a constant speed, if E is the E.M.F. of the machine, the difference of potential at the brushes when a current flows will not be simply $E - Cr$, but $E - C\left(r + \frac{\pi n L}{120}\right)$ or calling the resistance due to self-induction, p, the difference of potential at the brushes becomes $E - C(r + p)$.

But even when we include in the expression the effect due to the self-induction in the armature, it does not completely represent the fall of potential at the brushes of the dynamo. Fig. 2 shows some results obtained from a larger size series machine. The working current of this machine is 20 ampères, with which the field-magnets are fairly well saturated. The first curve, A, (fig. 2) shows the fall of potential at the brushes of the machine when the field-magnets are excited with a constant current of 20 ampères, abscissæ as before representing current and ordinates difference of potential. Curve B shows the results when a current of 10 ampères is employed to excite the magnets, and curve C the results when the exciting current is only 5 ampères. The brushes were not moved during the experiments, and the speed was maintained constant at 1,600 revolutions per minute. If the fall of potential at the brushes were simply due to the resistance of the armature and to the self-induction of the armature coils, the line representing this fall would not be curved as in some of the examples, but a straight line gradually sloping from the highest point. Moreover, if these were the only two causes producing the result, the line would have the same slope, whatever be the strength of the field. Fig. 2 shows, however, that with different strengths of field we have very different values for the fall of potential due to increase of current, the difference being due to the reaction of the armature on the field-magnets, and depending on their relative sizes and windings. When the field produced by the field-magnets is large, compared with that produced by the armature, the curve is approximately a straight line, A, fig. 2, in which case the fall of E.M.F. in the machine, due to the demagnetising effect of the current in the armature, is directly proportional to that current. We see then that along with the fall of potential at the brushes, due to the resistance of the armature and the self-induction of the coils, we have a diminution of the E.M.F. of the machine, due to the weakening effect of the armature on the field-magnets. If we call E_1, the E.M.F. of the machine when the circuit is open; when a current, C, flows through the armature, the E.M.F. becomes $E_1 - Cq$, and the difference of potential at the brushes is consequently $E_1 - C(q + r + p)$, where r and p have the values before assigned to them, and q is a term depending on the relative proportions of the magnets and armature, and their respective windings. On fig. 2 is shown the fall of potential, due to the resistance of the armature, Cr, also that due to the weakening effect of the armature, and to self-induction $C(p + q)$.

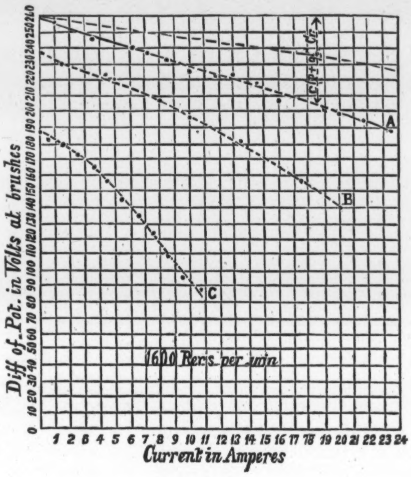

FIG. 2.

In every dynamo machine, whether separately excited or not, q, r and p, ought to be made as small as possible. The winding of the armature ought to be such as to enclose all the lines of force passing between the pole-pieces with a minimum length of wire; this keeps r small; also the winding ought to be such as to make the magnetic moment of the armature as small as possible; this makes q and p small. As an example of machine in which the method of winding makes p and q a minimum for a given number of turns on the armature, the Siemens dynamo might be cited; while, on the other hand, the Bürgin machine might be cited as one in which q, p, and also r, are excessive for a given number of turns. The armature of the latter machine is wound so as to employ, it would seem, a maximum length of wire for the enclosure of the lines of force, instead of a minimum, and the dividing up of the armature, and separate coiling of each piece, renders p and q very large indeed. Occupying a position midway between those two extremes come the Gramme machine, and generally machines having ring armatures.

In shunt dynamos, it is of special importance that q, p and r, be kept as small as possible, since the potential at the brushes determines the strength of the field, and any diminution due to the foregoing causes, immediately exaggerates the fall of potential by weakening the field-magnets. For this reason the curve connecting the difference of potential at the brushes with the current in the lamp circuit for a shunt machine, is never a straight line, but in a well constructed dynamo the curvature for a long range is small, and the slope very gradual. In fig. 3 is shown the curve for a shunt dynamo giving a current of 143 ampères and 50 volts. During the experiments the speed of the machine was maintained uniform at 1,500 revolutions per minute.

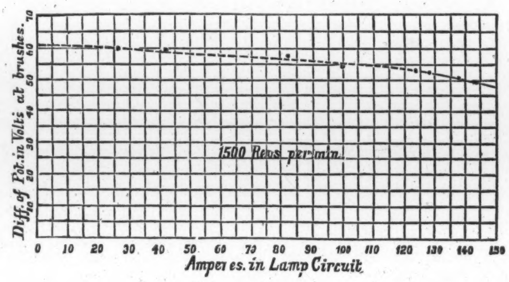

FIG. 3.

The fact of there being a certain E.M.F. expended in starting the current in the coils of the revolving armature does not affect any calculations respecting the commercial efficiency of dynamo machines, since, by commercial efficiency, we mean the ratio of the electrical energy utilised for lighting purposes, to the total energy expended in driving the machine; but it does affect the items of which the commercial efficiency is made up. For example, if in a series dynamo, R is the external resistance, r_1 the resistance of the armature, and r_2 the resistance of the field-magnets, it is generally assumed that the electrical efficiency is expressed by $\frac{R}{R + r_1 + r_2}$, taking for granted, of course, that the E.M.F. of the machine is $C(R + r_1 + r_2)$, where C is the current flowing. But it has been shown that the E.M.F. is really $C(R + r_1 + r_2 + p)$, where p has the meaning before assigned to it, and the electrical efficiency therefore becomes

$$\frac{R}{R + r_1 + r_2 + p}$$

or somewhat lower than before. On the other hand, the conversion efficiency of the machine is raised somewhat. More of the energy expended in driving the machine is converted into electricity, and less of the energy so converted is utilised.

W. B. ESSON.

The United Telephone Company, Limited.—The secretary announces that the offices, call rooms, and telephone exchanges of this company will be closed on Saturday, the 12th inst., as well as on Good Friday and Easter Monday (Bank Holiday), for the purpose of making certain additions and alterations which the recent rapid development of the company's system has rendered imperative.

THE LATE ELECTRICAL EXHIBITION AT THE CRYSTAL PALACE.

(Continued from page 288.)

Let me work out one case completely, so as to show the methods adopted to determine the efficiency of each machine.

I will select one of the three Bürgin machines (the C_3 machine) submitted by Mr. Crompton. In the C_3 machine the resistance of the armature (cold), a, = ·528 ohm; the field magnet, f, = ·435 ohm; the difference of potential, p, = 92·8 volts; and the current, 31·18 ampères.

To determine the difference of potential at the terminals—

Let d be the deflection of the galvanometer on discharging a condenser after charging it from the standard cell, let B be the mean deflection on discharging the condenser after charging it from the machine terminals, t the ratio between the values of the shunts employed; then $p = \frac{tB}{d} \times 1·457$ volts. In this case $t = 10·47$, $B = 219·1$, $d = 36$; hence $p = 92·843$ volts.

To determine the current, C, in the external circuit—

(1) *By the Condenser.*—Let b be the mean deflection on discharging the condenser after charging it from the terminals of the tangent galvanometer circuit, and m_1 the resistance (hot) of wires on the frame; then $C = \frac{b \times 1·457}{d\, m_1}$. In this case $b = 148·6$ and $m_1 =$ ·158; hence $C = 38·064$ ampères.

(2) *By the Tangent Galvanometer.*—Let θ be the deflection of the tangent galvanometer, k its constant, g its resistance, m the resistance of wires used in the experiment; then $C = \frac{\tan. \theta \times k \times g}{m_0}$. In this case $\theta = 47·67°$, $k = 3·469$, $g = 1·559$, $m = ·155$; hence $C = 38·30$ ampères.

The mean value C_0, from these two results is 38·182 the external resistance, r, $= \frac{p}{C_0} = \frac{92·843}{38·182} = 2·4316$ ohms, the internal resistance $(a + f)$ of armature and field when hot from the current is 1·02 ohms; hence the whole resistance is 3·4516 ohms, and the whole electromotive force of the machine $= C_0 (a + f + r)$ = 131·79 volts.

Now with regard to the efficiency of this machine, the number of watts $= C^2 (a + f + r) = 5,031·5$, and the electrical horse-power $= \frac{C^2 (a + f + r)}{746} = 6·7461$.

Now the actual horse-power applied as measured by the dynamometer, deducting the horse-power required to overcome the friction at the driving speed, is 7·7018; hence the electrical efficiency of the machine, *i.e.*, the fraction of the power applied, which appears as power in the shape of electric current, is $\frac{6·7461}{7·7018} = ·8759$, or nearly 88 per cent. Of this, the fraction which appears in the external circuit is the ratio of the external resistance to the total resistance, $= \frac{2·4316}{3·4516} = ·70448$. Hence the external or the useful electrical efficiency is 61·7 per cent.

On comparing the two methods of measuring the current we have the following results:—

By condenser method.	*By Tangent Galvanometer.*
$C = 38·064$.	$C = 38·30$.
$r = \frac{92·843}{38·064} = 2·4391$.	$r = \frac{92·843}{38·30} = 2·4241$.
Total resistance = 3·4591.	Total resistance = 3·4441.
E.M.F. = $C \times 3·4591$ = 131·67.	E.M.F. = 131·91.
Units of work, or watts, 5012.	Watts = 5053.
Electrical H.P. = 6·7191.	Electrical H.P. = 6·7731.
H.P. applied, deducting for friction, = 7·7018.	H.P. applied, deducting for friction, = 7·7018.
Electrical efficiency = ·87241.	Electrical efficiency = ·87943.
The fraction of this appearing in the external circuit = ·70513.	Portion in external circuit = ·70383.
External electrical efficiency = ·6152, or 61·52 per cent.	External electrical efficiency = ·6190, or 61·90 per cent.

Thus the difference in the two methods is only about two-thirds per cent. on the efficiencies.

For machines with a separate exciter, such as the Maxim machine and the H Gramme machine, the same methods were adopted for finding the current and the potential at the terminals, but in the case of the exciter the current was obtained from the potential at two points, and the resistance measured between them by the Wheatstone bridge immediately after the experiment whilst the portion of the circuit was still warm.

In shunt dynamo machines the potential was determined at the terminals, and the current in the field-magnets determined from their resistance measured (warm) by the Wheatstone bridge immediately after the experiment. The current in the external circuit being determined by the same methods as before, and the external resistance when running deduced from this current. In this case the total resistance is the resistance of the armature together with the combined resistance of field and external circuit. The total current, C, is the sum of these two currents. Hence the E.M.F. of the machine $= \mathrm{C}\left(a + \frac{f\,r}{f + r}\right)$ where

$$\mathrm{C} = \mathrm{C}_0 + \frac{p}{f} = \mathrm{C}_0 + \frac{t\,\mathrm{B}}{f\,d} \times 1{\cdot}457.$$

It will be seen from the table of efficiencies of these dynamo machines (see. p. 257, March 29th) that there are several which are capable of converting into electrical energy more than 80 per cent. of the energy absorbed, and that some convert more than 90 per cent., so that as converters of energy they are very efficient machines. But in some of these the internal resistance is so high, as compared with the external, that there are only five which give more than 80 per cent. of their electrical energy in the external circuit, *i.e.*, the useful electrical energy is only 80 per cent. of the total electrical energy.

The Edison machine, with thick copper rods or bars in the armature, converts into electrical energy 91 per cent. of the absorbed power, and of this amount 91 per cent. appears in the external circuit, so that $\frac{91}{100} \times \frac{91}{100}$, or ·83 of the absorbed power appears as useful electrical energy in the external circuit.

Of the others there are only three, viz., the B Gramme, the Maxim, and the Weston, which convert over 70 per cent. of the power applied to them into useful electrical energy.

After discussing the Bürgin C_3 machine so fully, it is only fair to Mr. Crompton that I should state that since these tests were made he has entirely altered the internal resistance of his machines and their general arrangement, and has greatly improved their total efficiency as well as their useful electrical efficiency.

Through the kindness of Dr. Hopkinson I am able to give you the latest information with regard to the Edison-Hopkinson dynamo machines. One of these machines was tested by Mr. Sprague after our tests were made at the Crystal Palace, and he found that 94 per cent. of the absorbed energy appeared as electrical energy. A large Edison-Hopkinson machine on board the *Oregon* supplies 520 Edison A lamps with a current of ·72 ampères each, and the E.M.F. is 107 volts, so that the amount of useful energy is 40,000 watts. The resistance of the field-magnets is 17 ohms, and of the armature less than ·01 ohm when warm; hence the current in the magnets is about 6 ampères, and the total current in the armature 380 ampères. The energy spent in heating the field-magnets is $\frac{107^2}{17} = 670$ watts; in the armature is $380^2 \times {\cdot}01 = 1{,}444$ watts; thus only 6 per cent. of the electrical energy is spent in heating the machine, and 94 per cent. of the electrical energy appears as useful electrical energy in the external circuit.

Thus $\frac{94}{100} \times \frac{94}{100}$, or ·88 of the power absorbed, is converted into useful electrical energy. The 83 per cent. efficiency of the Edison machine has been raised to 88 per cent. by the improvements introduced into it by Dr. Hopkinson.

In considering these efficiencies of dynamo machines, as well as all efficiencies which have been determined up to the present time, it is important to remember that they depend upon the value of our unit of resistance in two ways—(1) directly, because we are measuring resistances, and (2) indirectly, because in measuring electromotive forces we take as our standard a unit of electromotive force which depends upon the value of our unit of resistance.

Thus Clark's standard cell is said to have an electromotive force of 1·457 volts, but this number is derived from the B.A. unit of resistance, which several experimental tests by Lord Rayleigh and by others have shown to be ·9865, or more than 1 per cent. below the theoretical unit of resistance. The E.M.F. of Clark's cell and of standards of E.M.F. must be altered to the same extent to suit the Rayleigh ohm. Hence all efficiencies of dynamos which have been hitherto determined must be more than 1 per cent. too high, and should be reduced in the ratio of ·9865 to 1.

Having considered the efficiency of the dynamo machines for converting mechanical energy into electrical energy, which may be regarded as another form of energy of motion, we have now to consider the reconversion of this electrical energy back again into heat and into energy of radiations, as we compare the candle-power with the energy expended under different conditions in incandescent lamps.

(*To be continued.*)

REVIEWS.

Lectures on Electricity.[*] By JOHN TYNDALL, F.R.S., &c., Professor of Physics in the Royal Institution of Great Britain. Translated into German with the author's sanction by Joseph von Rosthorn. Vienna, Pesth, Leipzig.

This work, like its companion volume, is well known in England, as embodying a course of lectures delivered at Christmas last in the Royal Institution. The translation is clear, faithful, and idiomatic. The publishers deserve great praise for the style and getting up of the work. Paper, letter-press, and illustrations are all excellent.

Electrical Phenomena and Theories.[†] A brief abstract of a course of Seven Lectures delivered at the Royal Institution of Great Britain, by JOHN TYNDALL, F.R.S., Professor of Physics in the Royal Institution of Great Britain. Translated into German, with the author's sanction, by Joseph von Rosthorn. Vienna, Pesth, Leipzig: Hartleben.

Concerning this work, little can or need be said. It is a reproduction of a well-known course of lectures by Professor Tyndall, in clear and elegant German.

Electricity and its Applications.[‡] A seasonable New Year's gift for 1884. Milan.

This work is compiled by Enrico Bignami, with the collaboration of a number of eminent Italian physicists, each of whom furnishes a section.

The first chapter, bearing the same title as the entire work, is furnished by Prof. Pietro Pezorini, and gives a general historical survey of the subject. Here a very considerable emphasis is laid on the results lately obtained by Marcel Deprez in the electric transfer of power. The author describes these experiments at some length, quotes the favourable opinion expressed by M. Bert, and expresses the confidence that by this means Italy may derive great benefit from the utilisation of the mountain torrents descending from the Alps and the Apennines.

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[*] *Vorträge über Elektricität,* von J. Tyndall, F.R.S., Prof. der Physik in der Royal Institution of Great Britain. Mit des Autor's Erlaubniss ins Deutsche übertragen von Joseph von Rosthorn.

[†] *Elektrische Erscheinungen und Theorien.* Kurzer Abriss eines Curses von sieben Vorlesungen, abgehalten in der Royal Institution of Great Britain, von John Tyndall, F.R.S., Prof. der Physik in der Royal Institution of Great Britain. Mit des Autor's Bewilligung ins Deutsche übertragen, von Joseph von Rosthorn.

[‡] *L'Elettricita e le sue Applicazioni; Strenna del Giorno pel* 1884.

The second chapter discusses the general principles of electricity and magnetism, and is communicated by Prof. Ferrini, being, in fact, taken from his treatise, "Elettricita e Magnetismo." These principles are laid down in a number of detached paragraphs. We find here an account of the law of Coulomb, the experiments of Riess, Coulomb, and Hæcker, the definition of the magnetic field as furnished by Sir W. Thomson, the theorem of Volta, the laws of Ohm, Long, and Jacobi, and an explanation of the standards of electric measurements.

The electric light, and the various forms of lamps, are the subjects of an extensive section by A. Casanova. This author gives a history of the electric light from its first discovery down to the present day. He describes the arrangements for the arc light, for incandescence, or glow lamps, the means of producing the necessary electric currents, such as the hydro-electric, the secondary, and the thermo-electric batteries. He then treats of electric induction and the principles of magneto-electric machines, several of which are described and shown in illustrations. The style of the figures is, however, not equal to that which we generally find in French, English, and American treatises. A. Casanova then passes on to an account of the distribution of the electric light, the system of M. Marcel Deprez taking a prominent place.

Some of the especial uses of the electric light are next described, as in lighthouses and in military operations. Here the writer notices its employment by the French in disembarking on the coast of Tunis, and adds a reflection on the manner in which science is made to minister to the caprices of human ambition. The introduction of the electric light for civil and industrial purposes is duly considered, and strong hopes are expressed of its future utility. We can scarcely see the reason for introducing a figure of the "solar motor" in this connection. This novel source of mechanical power may come into practical use in Australia and Africa, and may of course serve to drive dynamos; but in no part of Europe is the sun light sufficiently free from interruption.

The succeeding chapter, on electricity applied to the transmission of signals—in other words, to electro-telegraphy and telephony—is from the pen of P. Meardi.

Erminio Ferraris gives a preliminary account of an arrangement for electrolytic purposes, as in electro-metallurgy, galvano-plastics, &c. This chapter is short, and might easily have been rendered more instructive.

Dr. A. Baratieri treats of electricity in reference to the animal economy. In this chapter we find mention of the electricity of the gymnotus, and of the original experiment of Galvani, but there is nothing which can be called suggestive.

Dr. P. Schivardi discusses electro-therapeutics—a much abused subject.

The concluding chapter contains practical instructions for the application of electricity to household uses, and is of a somewhat promiscuous character. It includes the installation of the electric light without a motor, by means of the Gardine battery; the arrangement of electric bells, indicators, telephones, electric motors, gilding and silvering, the Mucci voltameter for medicinal purposes, and the determination of the poles in the battery.

There is little in this treatise to which direct exception can be taken as inaccurate. But the various sections are very unequal in their merit, and errors of arrangement are not wanting. Thus, in the section on animal electricity, we find much that belongs to the general elements of electrical science, and such "piper's news" as that "the atmospheric air is a body," or that "our globe is formed of a quantity of points, such as mountains, pyramids, obelisks, trees, church-towers." Very true, doubtless, but having little especial bearing upon the electric manifestations in animals.

The electric transfer of mechanical power, though referred to in the introductory section, is not made the subject of a distinct chapter.

THE EFFICIENCY OF SECONDARY GENERATORS.

WE observe that we are not alone in criticising the recent report given by Dr. Hopkinson on the Gaulard-Gibbs system of electrical distribution. M. **Jules** Sarcia writes as follows in the last number of *La Lumiere Electrique:*

"In the calculations for percentage of efficiency we see two grave errors of a theoretical nature. The first is the violation of a well known arithmetical theorem; in the second, Dr. Hopkinson unduly applies Joule's law which, as is shown in all classical treatises, is not applicable to alternating currents.

Let us examine first the arithmetical error. We will designate by T the electric work furnished by the primary machine at the terminals; by t the electric work of the secondary generators, and by c the heat absorbed by the line. The individual return of the secondary generators is, by definition, the relation of the energy, t, which they give to that which they receive from the primary current. Now the energy which they receive is no other than that which is developed at the terminals of the primary machine, minus the caloric energy absorbed by the line, that is to say, $\text{T} - c$. The return is therefore expressed thus—

$$\frac{t}{\text{T} - c}$$

Now, Dr. Hopkinson does not proceed thus, he takes for the numerator of the fraction which expresses the rendering, the work of the secondary generators (9513 + 1875) augmented by the caloric work of the line (3630), that is to say, $t + c$, and for the denominator he takes, on the contrary, the work, T (16,710 watts) of the primary machine. The rendering thus defined would be equal to

$$\frac{t + c}{\text{T}},$$

which we may write

$$\frac{t + c}{\text{T} - c + c},$$

It is, therefore, the true expression of the rendering in which we have added the same number, c, to the numerator and denominator. Now, an elementary arithmetical theorem teaches that we increase the value of a fraction when we add the same number to the numerator and to the denominator.

The expression of Dr. Hopkinson is, therefore, always higher than the true rendering, and that in consequence of an error against the principles of arithmetic, the electric methods being accepted without discussion.

Let us see, now, how Dr. Hopkinson calculates the caloric work, c, absorbed by the line. For this he simply measures, by means of the electro-dynamometer, condemned at the beginning of his report, what we may call the intensity of the primary alternating current, he squares this intensity, and then applying Joule's law he multiplies by the resistance of the line, and finds 3,630 watts. Now, this mode of proceeding is inadmissible, since, as said above, it is impossible to draw any conclusion from the indications of the electro-dynamometer when it is applied to alternating currents. In order to be consistent with himself, Dr. Hopkinson ought to have applied to the line the method of M. Joubert.

We will point out, lastly, two important omissions.

Dr. Hopkinson says, at the commencement of his report :—"On the 11th of March, the whole of the electric force developed by the alternating current Siemens machine was determined by the aid of six readings . . . . &c."

What does he understand by "the whole of the electric force of the machine?" Is it the electric work at the terminals, or the total electric work including the energy measured at the terminals, augmented by the caloric energy absorbed by the machine itself?

Second omission : The resistance of the wires of the primary bobbins receiving the high tension current should not be ignored, for the primary circuit necessarily consists of a wire of great length. To find the true coefficient of transformation, that is to say, a number independent of the conductivity, more or less great, of the wires of the transformer, Dr. Hopkinson should have taken into account the resistance proper of the circuit of the primary bobbins as well as that of the line itself, and he would have then, in all probability, found a rendering very near unity and—who knows?—perhaps a little higher than unity.

Lastly—and this is not the point least worthy of remark in the report—after having found this astonishing rendering of 90 per cent., Dr. Hopkinson does not express the least surprise; it seems that he is quite used to figures of this kind.

In summing up, we think that Dr. Hopkinson owes to himself and to the discriminating public the most complete development of the smallest details of the experiments which have led him to the results which we have just made known. We await the publication of these details to appreciate at its true value the process of transformation of currents based upon the employment of the induction coil."

THE ELECTRIC TRANSFER OF ENERGY.

Researches of M. Marcel Deprez.

Summary of Experiments.

By FRANK GERALDY.

Translated from *La Lumière Electrique*.

To the theoretical explanation which has just been put forward, it is necessary, in order to give the reader a complete idea of the researches of M. Marcel Deprez, to append a rapid sketch of his experimental studies—the trials which have been successively made, and which have taken up the years 1881, 1882, and 1883.

The starting point of these labours may be, perhaps, referred to the Electric Exhibition of 1881. Doubtless M. Marcel Deprez had experimented before this date, but it was in his laboratory, on a limited scale. Several persons have, indeed, had the opportunity of seeing an instance of distribution effected in his laboratory, but it was at the Palace of Industry that he displayed his results for the first time to the public.

The installation which he erected there was an instance of the electric transfer and distribution of energy. As regards the transfer, it does not differ widely from what had been effected by others. The total length of the cable was about 1,800 metres; very well at that date, but not exceptional. The power collected was not measured, but about four horse-power was expended. It may be said, further, that at that date there was no great interest felt in measuring, with precision, the power and the result, an affair which shortly afterwards became of such importance. To succeed in transferring power under any conditions seemed then an interesting result. From this point of view the installation of M. Marcel Deprez seemed about as good as any other. The feature in which it was unrivalled and altogether exceptional was, that not content with merely transmitting power, it distributed such power among numerous distinct machines, each acting independently of the others; in a word, it worked with distribution. This was the first realisation of the principles which have been already expounded. We reproduce here, fig. 1, the two dynamo machines which produced the current. The double cable conveying the current went entirely round the Palace of Industry, with derivations both on the ground floor and on the first storey, to 27 distinct apparatus, some detached, and others arranged as in a workshop, and comprising sewing machines, folding machines, machines for ribbon sawing, for wire weaving, arc and incandescence lamps, and, lastly, a printing press. Each apparatus had its small electro-motor, most of them a magneto-electric motor on the Marcel Deprez system; some, among others the press, had small Siemens dynamo machines.

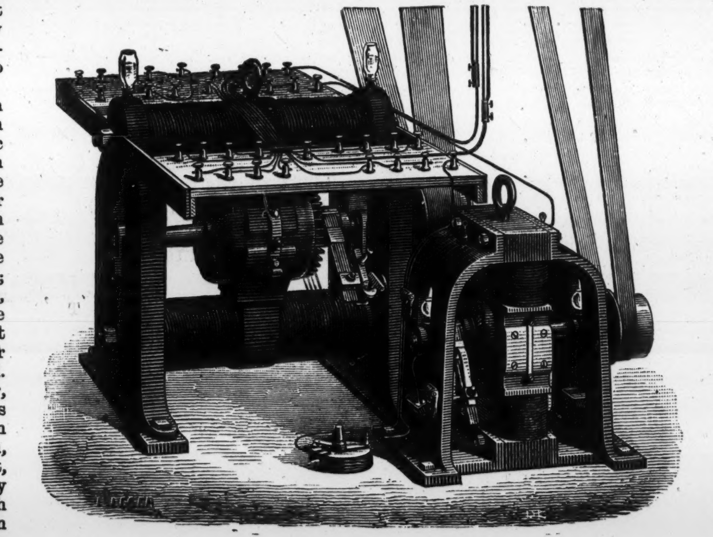

Fig. 1.

This was certainly a mere experiment, but on a large scale, approaching to practical dimensions. At any rate it was very novel, and, as was generally remarked, it was at least a brilliant departure which promised well for the future.

In the International Congress of Electricians, in 1881, M. Deprez had explained his ideas and the general theory of the transfer of power such as he had conceived it; this theory, we may remember, has encountered much contradiction. The application, as it was said, was limited both as to the distance and the quantity of power. It was necessary to go further—to confirm the theory by precise experiments, and to carry out its application on a scale of industrial utility.

It is true that the author was not obliged to himself undertake these tasks. Many men of science, having announced an idea, stop, and do not consider themselves called upon to carry it personally into practice. This is doubtless allowable, and they have, after all, fulfilled their duties as savants and theorists. But if we cannot blame them, we should praise those who do not recoil from the arduous task of giving a material form to their ideas—an arduous task which demands, besides the attributes of the savant, others lower perhaps, but not less rare, among which must rank first and foremost, a persistence which nothing can weary.

The first step on entering upon this experimental career was to verify, fundamentally and completely, the various bases upon which rests the theory proclaimed at the Congress, explained, afterwards, before the Academy, and produced before the public in *La Lumière Electrique*.

The details already given embody the most striking results of these experiments. As may be supposed, these are merely instances selected from a great many others. Especially as regards the characteristic curves, it was established by means of machines as numerous and as different as possible. Thus a very complete knowledge of the various types was acquired; the instruction collected was very precious for future improvements, and for preparing designs of machines which may be constructed hereafter.

In the meantime, everything was being prepared for experiments on transmission to a great distance. It will be remembered that one of the first theoretic researches of M. Deprez (*La Lumière Electrique*, Aug. 24th, 1881) consisted in showing that with existing types of machines we might, by the aid of a transformation mathematically calculable, succeed in effecting a transfer to a great distance. The calculations were based on experiments made by English Engineers at Chatham with electric light machines. The data furnished by these experiments were very vague, as they had not been undertaken for the object aimed at by M. Deprez. The first experiments, however, carried out in the laboratory permitted them to be completed, and a transformation could be undertaken conformably to theory, and which must effect the purpose aimed at.

The utility of this experiment may be conceived. Of course, it cannot completely answer the conditions to be fulfilled, and can yield the result only with difficulties, in a troublesome manner, and liable to accidents. In order to succeed fully it was necessary to construct new machines. This fact was not overlooked, but this construction presupposed long studies. It was necessary to examine separately the influence of each part. Then, when the type was determined, time was still needful to effect any required correction. The use of these machines allowed of rapid experiments at a moderate cost, and had the immense advantage of placing the principle beyond doubt, of replying to objections, and of securing the future by establishing a firm point of departure.

The machines selected for conversion were two Gramme machines of the workshop model. They were fitted with new coils of finer wire, were modified in several of their parts, and were finally used in the experiments. On February 13th, 1882, M. Marcel Deprez was able to announce to the Academy that he had succeeded in transmitting 27 kilogrammetres against an artificial resistance of 786 ohms, representing a length of 78·6 kilometres of telegraph wire. The return was estimated approximately at 25 per cent.

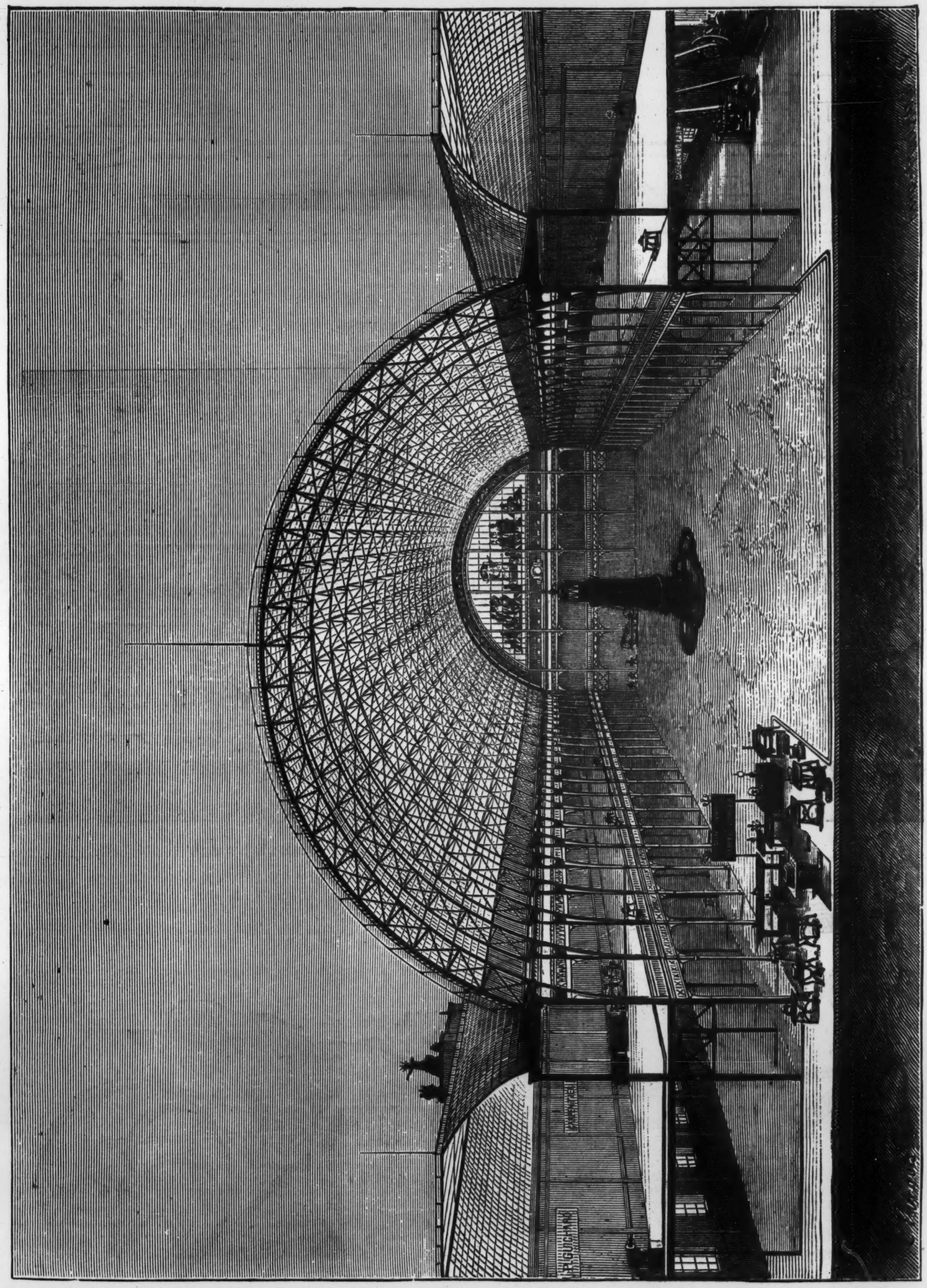

FIG. 3.—GENERAL VIEW OF THE DEPREZ ARRANGEMENT, PARIS EXHIBITION, 1881.

It must not be believed that the affair proceeded with the convenient rapidity which this brief account might lead the reader to suppose. Many obstacles were encountered, but not those which had been announced. We are not speaking here of M. Deprez and his friends, who knew approximately what might be expected. But, in the electrical world, it was said on all sides that this would never work. Each one had his reason. At the first trial the machines, it was said, were to melt, burn, and be destroyed by the heat. Not only did nothing of the kind occur, but no machines had ever been so cool. The most ordinary light machines heated incomparably more than these, The real difficulties encountered lay, as was known to those who had studied the question, in the novel use of high tensions. It was necessary to employ great care in insulation; to arrange commutators of new forms to prevent the origination of voltaic arcs, very

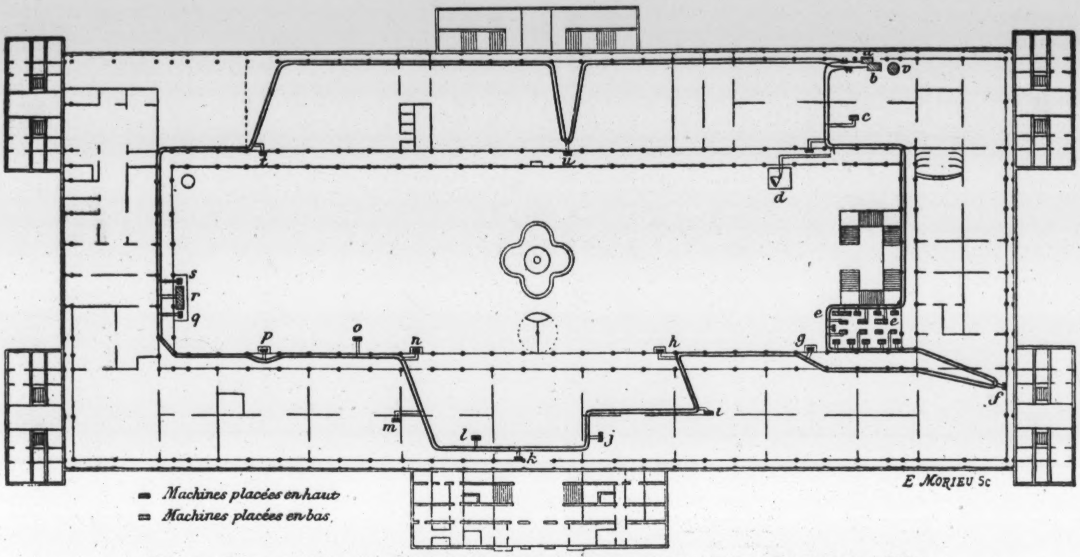

FIG. 2.—PLAN OF MARCEL DEPREZ'S SYSTEM OF DISTRIBUTION, PARIS EXHIBITION, 1881.

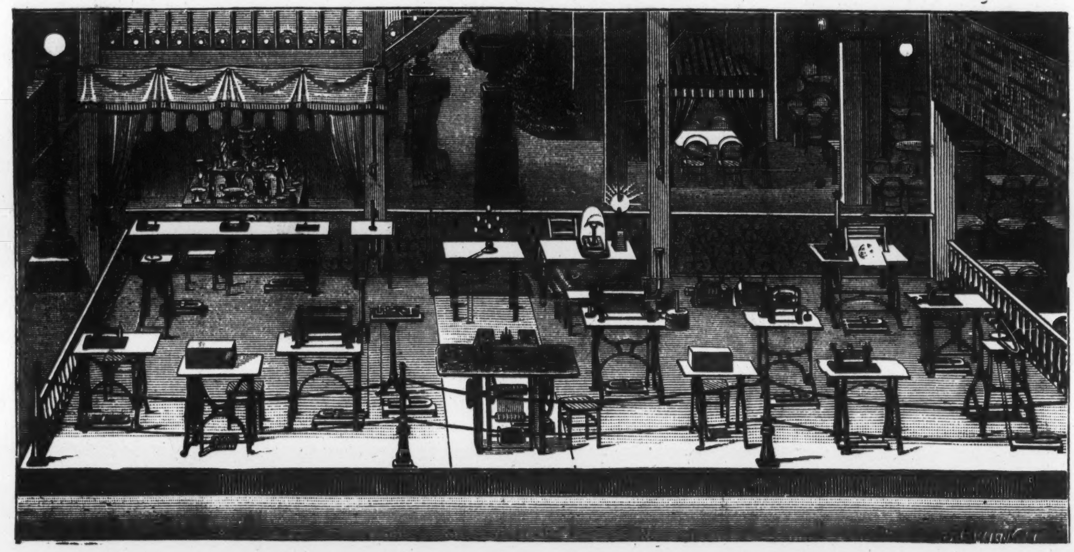

FIG. 4.—SMALL WORK-ROOM, FORMING PART OF MARCEL DEPREZ'S SYSTEM.

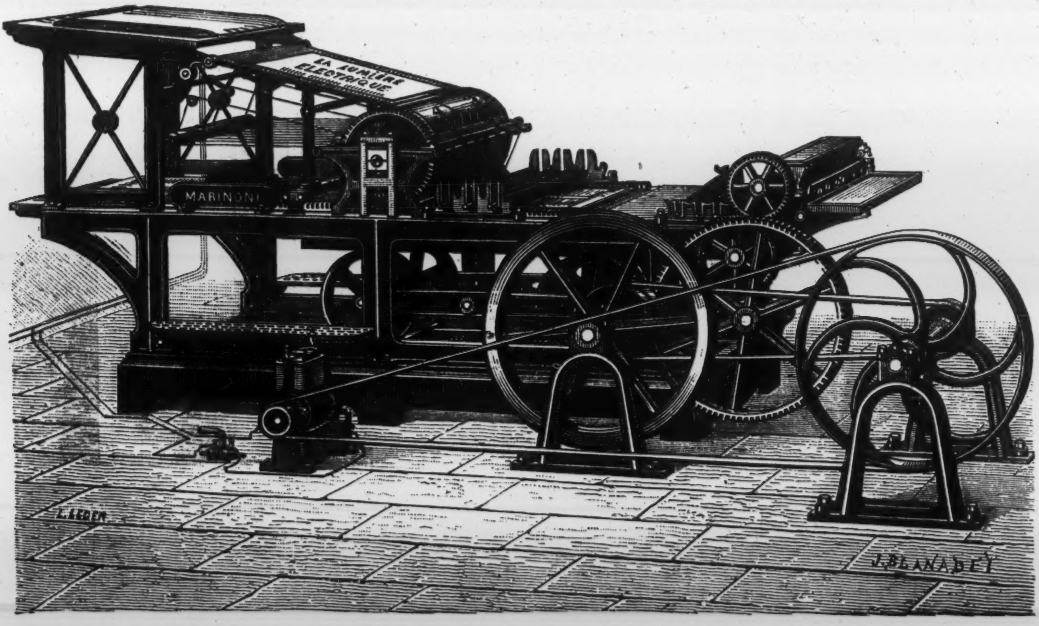

FIG. 5.—PRINTING PRESS FORMING A PORTION OF MARCEL DEPREZ'S SYSTEM.

difficult to extinguish at the moment of interrupting the current. It was even needful to employ especial methods for effecting the interruption, as any sudden break was seriously injurious. Thus, as we advanced, difficulties presented themselves, inherent in the use of electricity in this novel form, and successively they were overcome.

It was about the beginning of 1882 when the Technical Commission charged with organising the Electric Exhibition at Munich, placed itself in communication with M. Deprez. The question of transmission had been already raised at the Paris Exhibition, and it was decided to render it one of the main features of the Munich Exhibition. But, as may be understood, it was desired to present the transmission under novel forms and to show results which had hitherto not been seen. The Commission addressed itself to various German firms, asking their assistance. Messrs. Siemens & Halske declined the proposal, doubtless being able to do merely what they had done previously and not wishing to repeat themselves. Messrs. Schuckert accepted, and effected a transfer to the distance of five kilometres. The motor machine was impelled by a fall of water on the river Isar, at Hirschau. The conducting wire was of copper, and presented a total resistance of 12·61 ohms.

It is necessary to insist upon this point. We must carefully note that in transfers the distance does not act strictly by its length but by the resistance of the conducting wire necessary to connect electrically the two machines. Doubtless, we may diminish this resistance by selecting a good conducting metal and increasing the diameter of the wire. But this can only be done by increasing the expense. Now, we must remember that the transmission of power is not merely a scientific question, but should admit of an industrial application. Hence, economic considerations play an important, and even a preponderating part. If the transfer is to have any interest, the distance must be considerable and it must be traversed by means of a cheap conductor, that is, a wire relatively slender and therefore having a considerable resistance. As will be seen directly, the experiment of Messrs. Schuckert responded very imperfectly to these conditions, the distance being small and the conductor very thick. Hence this transfer did not differ essentially from former experiments, and especially from what had been done at the Palace of Industry in 1881. For the rest, no measurements were made with this transfer, which is the more singular as the Munich Exhibition was got up for the very purpose of securing precise data, and the apparatus were generally submitted to a thorough examination.

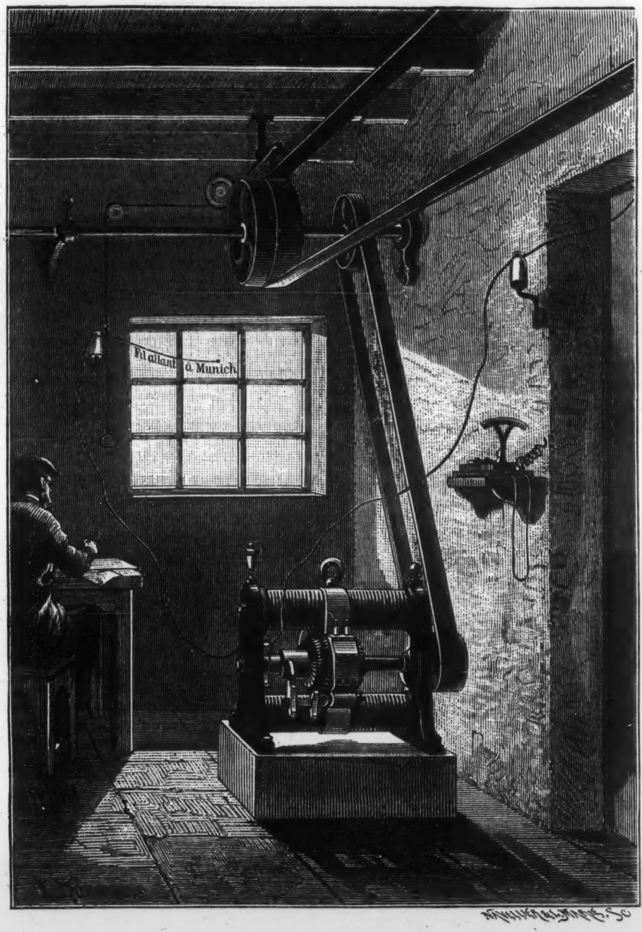

Fig. 6.—Installation at Miesbach.

We will say nothing of an alleged transfer effected at Munich by the Edison Company, the generating and the recipient machines being placed only at a distance from each other of 10 metres!

On the contrary, it is necessary before coming to the principal experiment, to say a word on a transfer of a peculiar kind exhibited by M. Deprez. As regards the distance of the transfer, properly speaking, it offers no novelty. But it displays an interesting manner of utilising electric action for the production of mechanical work. In the course of the experiments, solenoids have been studied, and it has been found that the attractions developed in these apparatus are very energetic. But in their ordinary arrangement they cannot give great displacements, nor, consequently, much work. By an ingenious arrangement, M. Deprez constructed a solenoid of a series of small, very flat solenoids, superimposed. Each of them is connected to the preceding one so as to form a continuous whole. But at the junction of two sections there is a stop of copper and these stops together form a collector, like those of the Pacinotti-Gramme machines.

Two rubbers convey the current, comprising between them a certain number of contacts, for instance, 10. There is, then, in the column forming the solenoid an acting portion traversed by the current, formed of 10 sections. By causing the brushes to travel along the commutators we cause at the same time the active portion to move along the solenoid and the iron core will follow it. We may thus raise it rapidly, cause it to descend in the same manner and make it act like a steam hammer. The power produced has been brought up to 180 kilos; at Munich it was 70 kilos. Fig. 15* of the foregoing article represents this apparatus.

We now come to the most important experiment.

M. Deprez having announced that he purposed working to great distances, the Commission immediately proposed to him to go to 50 kilometres, and offered him as conductor, an ordinary telegraph line. Here were certainly conditions quite exceptional, nothing of a similar kind having yet been attempted. As to the resistance to be overcome, M. Deprez was prepared; we have described one of his experiments in which he traversed in his laboratory resistances greater than the 500 ohms of a line of 50 kilometres. But there remained a doubtful point—to know how a telegraph line would behave, if its insulation was sufficient, if atmospheric disturbances had any influence. Experience alone could answer. To accept the investigation thus publicly, at so great a distance and under such conditions, was certainly bold. M. Deprez was bold enough, and he was justified by success.

It must be added that at this time he had no dynamos furnishing high tensions save the two transformed Gramme machines which have been previously mentioned. These apparatus were originally imperfect, and were already a little injured by the experiments for which they had served. These he sent on to Munich. The first project was to effect the transmission between Augsburg and Munich, but a Bavarian manufacturer, M. Fohr, who had works at Miesbach, a small town at the distance of 57 kilometres from Munich, urged that the generating machine should be placed there, and undertook to supply the necessary power. The distance was about the same.

As a conductor, the existing telegraph line was employed without alterations. It was at first intended to effect the return by the earth, but on further reflection this idea was abandoned and a second telegraphic wire completed the circuit. This arrangement certainly doubled the resistance of the line and, consequently, the difficulty of transport, but it was thought necessary to avoid danger. The effect of high electric tensions was then excessively dreaded; and if the earth was used for a return, the body of any person touching any point of the line would form at once a derived circuit.

It was subsequently found that high tensions were less formidable than had been supposed. Still, it is certainly imprudent to play with them, and a return wire seems a necessary precaution. It seemed still more important at the time in question. Thus arranged, the line offered a total resistance of 950 ohms according to the measurement of the Commission.

It must be said that, whilst inviting M. Deprez to carry out his experiment, it does not appear that the Munich Commission had much confidence in his success. Thus, on the day when M. Sarcia, the engineer employed by M. Deprez, announced that he would make his trial, many members of the Commission were present, and when, on the signal being given, the obedient machines began to move, there was a burst of applause. The machine at Munich was employed to work a rotatory pump, feeding an ornamental cascade.

The success was clearly and fully proved, but, as might have been expected, a number of small accidents interfered to limit its duration. On this subject it is best to quote the certificate given by the Commission:—

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* See Electrical Review for last week.

"The dynamo machines were set in motion for the first time on Sept. 25th, at 7 p.m., and, according to the data of M. Datterer, the engineer appointed by the committee, the receiver placed at Munich revolved at the speed of 1,500 turns per minute, the brake, serving to measure the work, being loaded with 1·5 kilog.

"A series of accidents, due to the fact that the machines were constructed for laboratory experiments and not for practical work, arrested, after eight days, the progress which up to that time had been completely satisfactory. The circles surrounding the ring of one of them broke, consequently the wires of the ring of 0·4 mm. in diameter were damaged, and had to be insulated afresh. In the remote town of Miesbach these repairs were effected with great difficulty, and required, on the part of the assistants of M. Marcel Deprez, much patience and perseverance.

"On Oct. 9th and 10th, when the Commission of Investigation commenced its measurements, the greatest speed attained at Miesbach with the repaired machine was 1,600 revolutions per minute; the results were consequently much less favourable than they had been with the normal velocity of 2,000 revolutions per minute obtained at first.

"During a few moments only it was found possible to reach, during the measurements, the speed of 2,000 revolutions per minute, and quite at the beginning of the experiments one of the brushes of the machine became detached, which produced an extra current and destroyed the machine."

It will be seen from these extracts that the results were obtained under disadvantageous conditions.

They are not, moreover, perfectly exact, especially from the transmission dynamometer at Miesbach having been made for 15 horse-power, was ill adapted for the measurement of small forces.

The results were the following: work received 0·25 horse-power, electric return 38·9 per cent. The mechanical return was not measured, but it is estimated at about 30 per cent.

All this, doubtless, was but a beginning; but it differed so widely from the attempts previously made, that a great outcry was raised. There was a brisk, indeed a violent, discussion on the results, the procedures, and everything which seemed open to attack. However, as was said by M. Cornu in a report to the Institute, to which we shall have to return below:—"The very violence of the polemic which has arisen on this question suffices alone to show that the author, if he has not solved the problem, has at least approached it very closely."

It was impossible to stop on so open a road. Along with these public trials, laboratory experiments were also advancing, and M. Deprez succeeded in deciding on the construction of his permanent machines.

On account of particular circumstances, and of a special application which was projected at this time, it was not proposed to adapt the first machine to a distant transmission, but it was thought desirable to receive a quantity of work of practical importance.

A beginning was made with a single apparatus; prudence demanding that in novel regions we should advance only step by step. The machine was completed about the end of January, 1883; it was tried, at first, in the laboratory, and appeared to answer all expectations, but it was necessary to try it in a more practical manner, and on a real line.

A telegraphic line is not an easy thing to find. It is true one was urgently offered, but it was in Bavaria. As a sequel to the success of the first former experiment, the administration of Munich had urged upon M. Deprez to repeat it with the machines which he subsequently constructed. He might have accepted this offer, but it implied going to a distance, leaving France, and carrying his performances abroad. This did not please the inventor. Among the French telegraphic lines there are some which the Administration often devotes to experiments. But these are more especially reserved for telegraphy. Besides, it must be said that the Administration had an exaggerated fear of high tensions, and was reluctant to see them upon its lines. M. Deprez addressed himself, therefore, to the Companie du Nord. The engineer of the telegraphic service, M. E. Sartiaux, with great kindness, found a line which it was possible to withdraw from the general service for a few days. The engineers of the depots, MM. Delebecque and Sauvage, found in their work rooms a corner and driving gear; the working service and its engineer, M. J. Sartiaux, took the experiment under their charge, and occupied themselves with the details. In a word, the company showed a good will, for which M. Deprez is exceedingly grateful.

(To be continued.)

Disastrous Fire from an Electric Spark.—A telegram to the *Times* from Philadelphia, on April 4th, states that the steamer *Rebecca Everingham* caught fire on the Chattahoochie River, some 40 miles below Columbus, Georgia, about daylight on the previous morning, her cargo of cotton having been ignited by an electric-light spark. She was run ashore within a few minutes. The passengers had been roused, but some of them had to escape in their night-clothes. Of 30 persons, about 14 were killed and several others injured. The boat and cargo were a total loss.

NOTES.

Electric Lighting.—We have received the following information respecting the "Pilsen" dynamo, which we presume is only another name for Schuckert:—"The Pilsen-Joel and General Electric Light Company, which has so largely introduced the now famous 'Pilsen' dynamo-electric machine into this country, which, by the way, has the advantage of being capable of maintaining a large number of lamps on a single circuit of wire, has now, in response to the steadily-increasing demand for incandescent lighting, produced another type of the machine, especially adapted to this purpose. The company's new machines have several novel features, both in the arrangement of iron in the armature core, and in the method of winding adopted to secure currents of great quantity for subdivision; they prove conclusively that if properly arranged, this type of machine becomes as prolific a generator of quantity current for incandescent work, as of high tension current for arc lighting. These types of machines, though giving widely different volumes of current, are almost identical in appearance. The machines are all made under the superintendence of the company's electrical staff at the factories, Malden Crescent, Kentish Town; the company's latest contracts being the lighting of the Armoury of the Tower of London, of the Bethnal Green Museum, for the Science and Art department, and the new Tilbury Docks for the contractors." We also understand that the company is now busily engaged in fitting up the electric light on board a new steam ship.

The *Portsmouth Times* of April 5th, states that the electric light was fitted on board the royal yacht *Osborne*, on Thursday evening last week, by Mr. W. Lane, the dockyard electrician, in a very short space of time, to enable Mr. West, of Gosport, to photograph the apartment containing the remains of H.R.H. the Duke of Albany. Sixteen 50 candle-power incandescent lamps were fitted, giving a brilliant illumination; the current was produced on board H.M.S. *Malabar* and conducted by wire to the *Osborne*.

We understand that Mr. Henry F. Joel, C.E., late of the Pilsen-Joel and General Electric Light Company, has been appointed by the Electric Lighting Committee of the Leeds Corporation to superintend the installation about to be made in the new municipal Buildings. We doubt not but that the lighting will be an entire success in the hands of an engineer of Mr. Joel's experience.

In our last week's issue we mentioned a machine at the Building Trades Exhibition driven from one of Hindley's engines. This was a "Gramme," compound-wound, and self-regulating, and it supplied lamps to five exhibitors besides Hindley's stall, and it was put up and run during the exhibition by Messrs. Laing, Wharton & Down.

Among various temporary installations carried out by Messrs. Laing, Wharton & Down, the lighting of H.M.S. *Rainbow* is specially deserving of notice. The ship has been fitted up for the occasion of amateur theatrical performances extending over several evenings, quite like a model theatre, and all the parts have been taken by members of the Naval Volunteers, the burlesque and music being written and adapted especially by one of the members. The ship was lighted throughout by 10 C.P. Swan lamps (rather over 40 being installed), these being distributed in the auditorium, footlights, floats, flies, gangway, canteen, &c., and all controlled from a switch board by the side of the stage. The auditorium lamps were all hung from ornamental flexible cords, and with silver-plated holders and various coloured Venetian shades; and as all the lamps were worked far above their normal candle-power, the effect was magnificent; the light being more than ample. On the stage the fittings were quite plain, and the light was very powerful. The current was derived from 15 double cells of the Holmes battery.

It is no doubt encouraging to those who are pecuniarily interested in the progress of the electric light that the first time an Established Church of England has been lighted throughout by electricity, the experiment has turned out a complete success. St. Matthew's Church, Brixton, is lighted by four arc lamps of 2,000-candle power, and sixty incandescent lamps of 16 to 20-candle power. One of the arc lamps is placed in the ceiling right over the pulpit and reading desk; the other three are distributed along the ceiling. The incandescent lamps are distributed under the gallery. All the lamps are so arranged that no wires can be seen in any part of the church. To use arc and incandescent lamps in one building may be thought a departure from the general rule of indoor electric lighting, but the remarkable steadiness of the Fyfe-Main arc lamps admits of great economy in supplying the necessary amount of light at the lowest possible cost. The order was given for a three months' trial, and so satisfied are the committee and churchwardens with the result that they have required the Fyfe-Main Company to enter into a bond to continue the supply. The churchwardens have paid for the outlay connected with the fitting up of the installation. The increased comfort through breathing purer atmosphere in the church has, we understand, materially assisted towards an increased attendance.

Electric Lighting Orders.—In the House of Commons, on Monday, Sir G. Campbell asked the President of the Board of Trade whether the Swan and Edison Electric Lighting Companies, which it was now proposed to amalgamate by a new Provisional Order and Act, had paid the sums which they were bound to pay within six months under the Acts of last year; whether the other companies which obtained orders for areas in the metropolis had paid up, or, if not, whether the orders were forfeited; and what was done about the insolvent Brush Company, which sought to be allowed to offer its orders for sale without having done anything whatever. Mr. Chamberlain: The Provisional Order to which the hon. member refers does not propose to amalgamate the Edison and Swan Electric Lighting Companies. The amalgamation has already taken place, and the order proposes to transfer to the amalgamated company the orders granted last year to the two companies. These orders provide that, if the promoters fail to deposit certain sums of money to the satisfaction of the Board of Trade within six months (which period may be extended by the Board of Trade), the orders may be revoked. After communicating with the local authorities, the Board of Trade have approved an extension of time to the 15th of October next in the case of the orders of the two companies, except as regards the South Kensington order, where the local authority objected. As regards the orders of the Metropolitan Brush Company, the Board of Trade have refused to grant any extension of time. The only other orders affecting the metropolis are the Hamstead order of the Hampstead Electric Light Company and the St. Giles's order of the Pilsen-Joel Company. In the former case an extension of time has been approved with the concurrence of the local authority. The Board of Trade have taken no steps to revoke any of the orders.

Lighthouse Illumination.—The *Morning Post* states, as we announced last week, that the place selected for the experiments in connection with lighthouse illumination is South Foreland, a most advantageous site for the purpose. Here three temporary wooden experimental towers have been erected in a straight line landward from the high lighthouse. The height of the towers is about 15 feet below that of the high lighthouse, which is 356 feet above the sea level. In the first of these temporary structures electric lights will be installed, in the second gas, and in the third oil lights. The electric lights will be produced by three of De Meriten's magneto-electric machines and lamps, each machine arranged for working at one-fifth, two-fifths, three-fifths, and at full power. The estimated intensity of the light for each machine at those powers being 6,000, 12,000, 18,000, and 30,000 candles respectively. These machines, which can be worked singly or collectively, as occasion demands, will be driven by the steam engines at present employed in producing the permanent electric lights at the South Foreland lighthouse.

The Telephone in Russia.—A telegram from Moscow announces that "MM. Slotposky and Cap-Herr, the inventors of the new telephone system for transmitting communications to great distances, have terminated their experiments on the Moscow-Brest line. Telephonic communications have taken place with Mojaisk, Hjattsk, Viagina, Yarkevo, and Smolensk. The experiments proved most successful. Moscow and St. Petersburg will now be placed in communication."

Telephone Dispute.—On Thursday, the third inst., at the Shoreditch County Court, before Mr. Prentice, the United Telephone Company sued Messrs. Hovenden, wholesale perfumers, of Berners Street, Oxford Street, and of City Road, for £40, the charge in advance for two telephonic points. Mr. A. Cock and Mr. Lee Roberts, barristers, appeared for the plaintiff company and the defendants respectively. The case submitted was that the plaintiff company had fitted up two telephones for the defendants, who had signed the usual stamped agreement to pay £40 in advance for 12 months' rent for the two connections. The answer of the defendants was that they asked to have a "private wire" connecting their Berners Street and City Road establishments, but were advised that the cost of this—£35 a-year—would not be so good an expenditure as £40 for two connexions with the Exchange centres, whereby the plaintiffs would have all the advantages of a private wire and connexion with the subscribers. The telephones were fixed, and the plaintiffs found that they had not got what they wanted, for they were "switched off" before they could complete their communications; hence they refused to pay. A verdict was given for the plaintiffs, but the judge said that the defendants had cause for action if they had not got what they had bargained for.

Telephone Injunction.—In the Chancery Division of the High Court of Justice, before Mr. Justice Chitty, on Thursday last week, the United Telephone Company brought an action to restrain Mr. Norton by injunction from infringing certain patents relative to telephones which were the property of the plaintiff company. The defendant had submitted to a perpetual injunction. His lordship made the order asked.

Telephone Companies and the Public.—In the City of London Court, on Monday, before Mr. Harrison, deputy judge, an action was brought by Messrs. Sercombe & Son, wine merchants, 71, Fleet Street, to recover from the London and Globe Telephone and Maintenance Company, compensation for damages by trespass on the roof of their business premises. Mr. M'Intyre was counsel for the plaintiffs, and stated that the case was one of considerable public importance. The defendant company had asked leave to put up wires on the roof in question, and permission was refused on public and other grounds; but, notwithstanding this, certain wires were fixed on poles, in the doing of which the roof was damaged. In fact, the company's men were at work at intervals for eight or nine months, creating no small annoyance. His Honour—Why did your clients not take the company before the magistrate? Mr. M'Intyre: I don't know; but they now seek redress here, the roof having been nearly destroyed. Several witnesses were examined to prove the damage, and correspondence was put in showing that the company denied liability. His Honour, however, found for the plaintiffs, with costs.

Submarine Telegraph Cables.—A despatch from Lord Lyons, forwarding the convention for the protection of submarine telegraph cables, signed at Paris on March 14th, has been printed and issued as a Parliamentary paper. The convention is signed by representatives on behalf of Great Britain, Germany, the Argentine Confederation, Austria, Belgium, Brazil, the Republic of Costa Rica, Denmark, the Dominican Republic, Spain, the United States of America, the United States of Columbia, the French Republic, the Republic of Guatemala, Greece, Italy, Turkey, Holland, Persia, Portugal, Roumania, Russia, the Republic of Salvador, Servia, Sweden and Norway, and the Republic of Uruguay.

Telegraphy in America.—The New York *Economist* states that the Postal Telegraph Company in America has submitted a proposition to the Senate Committee on Post Offices and Post Roads to undertake the transmission of telegraphic despatches, on behalf of the Post-Office Department, between certain designated points at fixed rates, and to extend their service, if a contract is made, so that within five years all the country east of the Mississippi and Missouri rivers, and south of the Omaha and Minneapolis shall be brought into communication, and within seven years to cover the entire Union.

American Telegraph Companies.—We learn from the *New York Herald* that, in the United States Circuit Court, on the 28th ult., Judge Wallace gave a decision in the suit of the Western Union Telegraph Company against the National Telegraph Company, the Baltimore and Ohio Telegraph Company, and the New York, West Shore and Buffalo Railroad Company. The complainant moved for a preliminary injunction to restrain the defendant companies from erecting and operating the telegraph line upon the land of the defendant's railroad, and from permitting any one of the defendants from using its right of way for such purpose. If this were done, the complainant alleged it would violate an agreement entered into by the complainant with the Jersey City and Albany Railway Company in 1880, which, it was contended, had been assumed by the West Shore Road. The complainant had already constructed a telegraph line 26 miles in length along the right of way of the railroad company. Judge Wallace denied the motion for the injunction, but said, "It is reasonable that the complainant be protected during the pendency of the present suit as regards the telegraph line already constructed," and granted the injunction as far as that was concerned. In the same issue of the *Herald*, the Baltimore and Ohio Telegraph Company announces that, in view of the refusal of the injunction, it will immediately begin to string 12 wires on the West Shore route to Chicago, and will have them open for business within 30 days.

The American Rapid and the Bankers and Merchants Telegraph Companies of Philadelphia, having consolidated in violation of the law, the City has commenced proceedings for the forfeiture of their poles and wires.

Sixpenny Telegrams.—In the House of Commons, on Thursday last week, Mr. Fawcett, replying to Mr. Puleston, said the time for the reduction of rates for inland telegrams would be announced by the Chancellor of the Exchequer in his Budget speech.

The London correspondent of the *Liverpool Mercury* says :—"There is to be no sixpenny telegram this year, after all. The Treasury stands in the way. Mr. Fawcett, with something of a failure on his hands in the shape of the Parcels Post, and much to do to make it a success, has not the requisite authority for carrying this reform at once, and Mr. Childers has been able to relieve his Budget of provision for the measure. In consequence of this determination, it is probable that the question will again be raised in Parliament this year, and the House of Commons is very likely indeed to decide again, as it did in a previous session, in favour of the change, which has been too long postponed."

Technical Education.—The Prince of Wales has formally urged upon the Corporation and the Livery Companies to lend still further aid to the City and Guilds of London Technical Institute, which is greatly in need of funds ; and the Corporation purposes to vote a further sum of £1000 provided the Livery Companies subscribe the rest of the £20,000 needed by the institute.

The Brighton Electric Railway.—Mr. Magnus Volk's electric railway at Brighton appears to be the subject of much heated discussion and contention at the meetings of the Town Council. That body met last week, and, in the course of their deliberations, a report of the Works Committee came before them dealing with Mr. Volk's electric railway and lift. The committee stated that at their meeting memorials were submitted signed by certain residents of Kemp Town, asserting that the proposed railway would be a source of great danger to those inhabitants and visitors who were constantly riding or driving along the Madeira Road, and requesting that steps be taken to stop the laying down of the line. The committee had resolved that the memorialists be informed that the Town Council had reserved power to control the traffic arrangements of the railway, and to terminate the agreement with Mr. Volk at short notice if either the railway or lift were proved to be a nuisance. Mr. Saunders, chairman of the committee, in supporting its action, said it would be premature to say that either was a nuisance until it had been given a trial. A warm discussion then ensued. Mr. Carpenter characterised the concession as outrageous, and said the east part of Brighton would be depreciated by an obstruction which was not for town purposes. Public rights had been conceded to the promoters of a speculation for private profit. Mr. Booth disputed the assertions of Mr. Carpenter, and said he believed the electric railway would be the means of developing the popularity of the east end of Brighton. Mr. Sendall said Mr. Volk had been induced to expend his capital upon an electric railway, unique of its kind in England, and now the council were asked to dash all his expectations to the ground without a trial. After some further desultory conversation as to the nature of the agreement between Mr. Volk and the Corporation, Alderman Hallett declared that the great majority of the residents of Kemp Town were in favour of the railway. Eventually the committee's proceedings were approved. The writer of "Wayside Notes" in the *Brighton Times* remarks :—"Mr. Magnus Volk, the local electrical engineer, who has been the means of introducing several useful electric appliances into Brighton, is now realising what other enterprising men have previously ascertained, viz., that there is unfortunately a class of people in Brighton who persistently thwart improvements and attractions. . . . For conferring this distinct boon on the residents of the Marine Parade and Kemp Town, Mr. Volk is being branded in memorials as a speculator who wants to ruin the Madeira Road. It really is too bad to thwart local enterprise by such squeamish nonsense."

Swan *versus* Edison.—The Berlin Patent Office (says a French contemporary) has just rendered a judgment, the importance of which is increased by the fact that a similar action is about to take place in France very shortly. This is the case of Swan *versus* Edison, in which the Swan company demanded that the claims of the Edison patent should be declared void. These claims refer to three distinct arrangements. The first is "an electric lamp consisting principally of carbon filaments of high resistance." The second refers to the manufacture of these carbon filaments. Lastly, the third treats of the mode of producing these carbons, and introducing them into a globe, in the interior of which a vacuum has been produced. The Swan company supported its claim upon four old publications relating to the electric light, of which one was dated 1845, and it contended that the Edison lamp was known before the taking out of Edison's patent, since they had previously produced an incandescent electric light by means of carbon rods. According to the description given by Edison's representative, the essential part of the invention consists in the production of a carbon in the form of a very thin flexible filament of any length, as well as in the manufacture of the lamp in which the said carbon or filament is employed as the source of light. The tenuity of the carbon material gives thus to the lamp special qualities; and, in order to realise this, the latter should be manufactured in such a way that it could not be confounded with any of the lamps previously tried. The plaintiff was unable to prove that a carbon filament had been used anterior to Edison's patent in an incandescence electric lamp; it was only in the form of rods or pencils that carbon had been employed, and then only once sucessfully. Before rising, the Court interpreted first the claims of the patent, and then affirmed that neither the object of the patent, as a whole, nor any of the three claims patented were known anteriorly. Consequently the application of the Swan company was rejected, the company paying costs.

Calcutta Exhibition Awards.—The second list issued shows the award of gold medals to the Consolidated Telephone Company and Winter, Winter & Co., each for electrical communication between trains; a silver medal to Ryland Brothers for iron telegraph wire; and a bronze medal to Doulton & Co. for telegraph pipes.

Lecture.—At the Whitfield Tabernacle, Tottenham Court Road, on Wednesday evening, April 2nd, Sir John Bennett gave an address on "Electric Exhibitions at Home and Abroad." In speaking of the telephonic exhibits at the Paris Electrical Exhibition, Sir John appears to be at his best, for he says:—"There was a large gallery for the reception of telephonic messages. When he entered there was a performance going on at the Opera, and by turning on the wires one could hear the singers, the orchestra, and even the shuffle of the feet of the ballet-girls, and if the ballet-girls said anything not quite proper they had to shut their ears."

Improvement in Conductors for Lightning Rods.—We observe in *Comptes Rendus* the following note by M. Callaud:—"Conducting cables, as they have hitherto been made for the War Administration, are buried in trenches dug in the earth; they are surrounded with coke. Moisture is allowed to penetrate this, in order that it may increase the conductivity of the conductor. This arrangement, which is very good when the cable is intact, may be defective if oxidation attacks the copper of the conductor. I have attempted to remedy this inconvenience by the following arrangement: I surround each wire of the cable with hemp impregnated with white lead or minium. I cable them in this state in strands of five wires, placing in the centre an unprotected core of copper (this does not require protection since it is surrounded by wires screened from dampness). When the conductor is cabled I apply a strip of linen, impregnated with white lead or minium, which covers the whole and forms a perfect preservative."

Telegraphic Charges in Victoria.—The *Colonies and India* states that Mr. W. Madden, M.L.A., recently introduced to Mr. Berry, Postmaster-General, a deputation from the residents of Nhill and North Lillimur to ask that the charge for telegrams from the latter place to Border Town, in South Australia, might be reduced from 2s. to 1s. per dozen words. Mr. Madden stated that the deputation desired Mr. Berry to make similar arrangements with the South Australian Government to those which existed between New South Wales and Victoria, whereby telegrams between Wodonga and Albury were charged at the rate of 1s. per dozen words only. Mr. Berry pointed out that the circumstances were altogether different. Albury was only three miles from Wodonga, whilst North Lillimur was fully 14 miles from Border Town. He promised, however, to communicate with the South Australian Government on the question. As an item of interest to old colonists in England, the same journal announces that the Roebourne telegraph line, Queensland, has been completed as far as First Station, Flint Cliff.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Swansea Telephonic Exchange Company, Limited.—The annual return of this company, made up to the 28th ult., was filed on the 5th inst. The nominal capital is £5,000 in £10 shares. The whole of the shares have been issued, and a call of £9 per share has been made. Twenty-one shares are fully paid, and the calls paid upon 479 shares amount to £4,312, leaving £209 unpaid. The paid-up capital, as shown by this return, is £527 in excess of the amount recorded in the previous return.

Electric Lighting Supply and Fitting Company, Limited.—At an extraordinary general meeting of the members of this company, held on the 5th ult., at 28, York Street, Westminster, the following special resolution was passed:—"That the directors be authorised to borrow any sum or sums of money not exceeding £2,000 in all, on the best terms possible, the interest not to exceed 6 per cent. per annum." The resolution was duly confirmed on the 19th ult., and registered on the 2nd inst.

Metropolitan (Brush) Electric Light and Power Company, Limited.—An order of the High Court of Justice, Chancery Division, dated 7th ult., was filed with the documents of the company on the 4th inst., directing the continuation of the voluntary winding up of the company under the supervision of the court. It is also ordered that the petitioners be allowed their costs out of the estate, such costs to be taxed by the Taxing Master.

Railway Electrical Contractors, Limited.—The offices of this company are situate at 19, Great Winchester Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Hammond Electric Light and Power Supply Company, Limited.

THE following report of the directors is to be submitted at the third ordinary general meeting of the shareholders, to be held at the works of the company, Appold Street, Finsbury, on Thursday next, at 12 o'clock noon:

In presenting their accounts for the year ending December 31st, 1883, and making their second annual report, the directors have to express their regret that they are unable to show any profit available for dividend.

The past 12 months have been essentially a period of probation in electric lighting, and the directors have deemed it their best policy to continue to lay the foundations of the extensive business which they are persuaded will soon have to be handled, and in so doing they have been unable to avoid a very considerable expenditure of money in exhibitions, experiments, advertising, travelling, &c., outlays which almost invariably accompany the establishment of a new business, which has to feel and fight its way before it attains an assured position.

Though the directors consider that it might be right to treat all sums so expended as amounts that have arisen in the establishment of the business, and that they could be fairly placed to the debit of the goodwill and concessions account, they have placed them to the debit of the profit and loss account.

They have however placed to the debit of a separate account all sums spent in securing the concessions, patents, &c., held by the company.

The profit and loss account bears the debit arising from the past year's loss on the company's trading, and also the amount which it is deemed prudent to write off the value of the stocks of the company, consisting of plant, machinery in use at the works of the company, or in its operations, and off the value of certain new machines on hand for sale.

The total balances of these two accounts are as follows: Profit and loss, £29,180 3s. 2d.; goodwill and concessions, £170,612 4s. 9d.; total, £199,792 7s. 11d.; less reserve fund, £2,500. Total, £197,292 7s. 11d. And the directors, in consultation with Messrs. Theobald Bros. & Miall, the auditors of the company, have given their careful attention to the best means of dealing with this item.

The Anglo-American Brush Electric Light Corporation, Limited, confronted recently with a problem almost identical, decided to reduce its capital by a sum which should fully cover a somewhat similar deficit, and the corporation's proposition was so thoroughly acquiesced in by the shareholders, and has had apparently such a good effect on the property of the corporation, that your directors have decided to recommend the same course in the case of this company, and a resolution with this object will be submitted to you.

If this resolution be carried there will not exist annually a bar to the payment to the shareholders of any profits that may hereafter be earned. The directors have been careful to value the assets of the company upon a basis which leaves little doubt that after the elimination of the above item every figure on the credit side of the balance sheet may be taken to represent the cash value of such asset.

The position of the company would, after the reduction of capital proposed, be roughly as follows: Debtor—Capital, 50,123 shares at 30s., £75,184 10s.; reserve fund for bad debts, £500; sundry creditors, £13,350 2s. 9d.; bills payable, £770 15s. 8d.; reserve fund, £8,188 2s. 1d. Total, 97,993 10s. 6d. Creditor—Stocks, £21,876 15s. 9d.; plant, £26,736 18s. 9d.; furniture, £423; debentures, £2,500; sundry debtors, £8,308 13s. 7d. Cash—Glyn, Mills, £17,317 16s. 2d.; in hand, £887 16s. 3d.; on deposit at Hoares, £5,695; total, £83,746 0s. 6d. Calls on shares—(£12,912 already paid), £14,247 10s. (shares in sub-companies, £2,820.) Total, £97,933 10s. 6d.

The practical experience of two years' working under various conditions in all parts of the country, has convinced the directors that the great aim and object to be kept steadily in view by an electric lighting company, that has resolved to become a pecuniary success, is to be able to deal satisfactorily with the growing demand for house to house lighting, in short, to be able to supply electricity for public and domestic illumination in the same way in which gas is supplied.

With this purpose in view, the company, at the close of last year, perfected the amalgamations with the various sub-companies and with the Ferranti Company, and the directors at the same time deemed it wise to compromise the pending heavy litigation with the Anglo-American Brush Corporation, and so leave themselves free to deal with positive business, untrammeled with the anxieties and uncertainties of a long and costly lawsuit, which, however it might ultimately have ended, could be profitable to neither company, and would undoubtedly be injurious to the cause of electric lighting generally.

Further, this company has founded "The Hampstead Electric Light Company," which has obtained the necessary Parliamentary powers under the Electric Lighting Act, 1882, empowering it to supply that particularly favourable district with electricity for house to house lighting, and a satisfactory measure of local support has been received, so that when the company begins its operations it will be able to rely upon immediate customers.

The directors believe that the successful establishment of one electric light supply company, such as the Hampstead Company, to deal with house to house lighting, will not fail to lead to an immense expenditure of capital by corporations and other bodies who severally hesitate to lead the way in starting the first undertaking on a large scale under the Electric Lighting Act; and from many quarters the directors have been urged to become the pioneers in this direction, as this company is in a position to successfully carry through such an undertaking as soon as the necessary capital is raised.

To deal with house to house lighting profitably it is necessary that the operations should extend over a wide area, and the directors take power by the first resolution to be submitted to you to raise the capital of the company to £525,000, with a view, at an early date, of issuing for public subscription £150,000 for the purpose sketched above.

The company now possess:—

(*a*) Well equipped works in which every form of apparatus connected with electric lighting work can be manufactured on the most economical basis.

(*b*) Special works for the manufacture of incandescent lamps, which are being made by machinery at a reduced cost.

(*c*) The patents for the Ferranti dynamo, which is held on high authority to be the only existing dynamo capable of supplying economically the power necessary for house to house lighting.

(*d*) A skilled staff of electrical engineers, constantly recruited from the Hammond Company Electrical Engineering College—founded by the company, and working at a profit.

(*e*) A practical knowledge of electric light engineering placing this company in the first rank in the business.

The directors desire to add that, under their recent arrangements with the Brush Company, though they still possess the Brush Concessions for Cumberland, the Cleveland district, Durham, Derbyshire, Hampshire, Lancashire, Northumberland, Staffordshire, Sussex, Warwickshire, Worcestershire, Westmoreland, and Yorkshire, they are not confined to the exclusive use of Brush machines or lamps in these districts, should customers prefer those of other types.

In order to promote greater economy in the operating expenses, the offices of the company have been removed to the Works in Appold Street, Finsbury, which will effect a considerable saving in rent, and render possible a large reduction in the staff. In view of the fact that the number of competing electric light companies is now so greatly reduced, the directors have resolved to close all the branches, and as they are of opinion that this company is now sufficiently well known throughout the country to transact its business from its central office, they see no object to be gained in incurring large expenditure on exhibitions, local advertising, trial installations, &c.

The directors regret to have to state that during the past year two of their colleagues, the Hon. S. C. Glyn, M.P., and Mr. Rhodes Cobb, have felt themselves compelled to resign their seats through ill-health and inability to pay that close and constant attention which the affairs of the company unceasingly require from the board. Their places have been filled by two gentlemen who are largely interested in the company, and have sound practical acquaintance with the business, Mr. Frank Cowlin Barker (Managing Director of the Anglo-Spanish Electric Light Company, Limited), and Mr. Francis Ince.

The directors beg to draw the attention of the shareholders to the following paragraph in the last annual report:—

"The directors beg to point out that, under his agreement with the company, the managing director, Mr. Hammond, receives nothing whatever in the way of direct remuneration for the very valuable services he has rendered to the company during the past year. They deem this plan undesirable in the best interest of the company, and at the suggestion of some of the largest and most influential shareholders of the company, and in view of the fact that Mr. Hammond's exclusive services, which were not covenanted for in the original agreement, are practically being given to the work of the company, a proposal on this head will be laid before you."

The chairman at the last annual meeting stated that under the circumstances the board recommended that, in the future, remuneration at the rate of £1,000 per annum should be given to the managing director, and the shareholders present approved the proposal. But in consequence of the nature of Mr. Hammond's original agreement with this company the board consider it desirable that the matter should be on formal record, and therefore the resolution, of which notice has been given, with reference to the confirmation of the agreement with the managing director, will be submitted for your formal sanction.

The Faure Accumulator Company, Limited.

AT the Cannon Street Hotel, on Monday, a meeting of the shareholders of this company, called by circular by Mr. Harcourt Turner, was held for the purpose of considering the steps to be pursued in consequence of the proceedings taken against M. Philippart, chairman of the company, in connection with the bankruptcy of the affiliated companies on the Continent. Mr. Harcourt Turner presided, and there was a fairly good attendance of shareholders.

The Chairman stated that, since issuing his circular, he had ascertained that M. Philippart had ceased to be chairman of the company, in consequence of his having become bankrupt; and, M. Cadiot having resigned his seat on the board, they were reduced to the position that there were now only two directors, both resident in France, and neither of whom could speak a word of English. Financially, the company was in a very bad state, the balance in the bank last week being only between £2 and £3, but there could be no doubt that they had a claim against the French Electrical Storage Company. Under the circumstances he would suggest that that meeting should be adjourned until after the meeting of the directors next week, and that a committee be appointed to investigate the affairs of the company and report to the adjourned meeting.

Mr. Adams suggested that a subscription should be taken for the purpose of taking counsel's opinion as to whether civil or criminal proceedings could not be instituted against the directors of the present company.

Sir Arthur Otway, chairman of the original Faure Company, remarked that he had had no connection with the company since 1882. It was certain that the time had arrived when the shareholders were entitled to have an understanding as to what had been done with their money, but he counselled them to do nothing rashly until after the meeting called by the directors for next Wednesday. He did not want to make any reproaches, but the shareholders of the original company, contrary to the wishes of the directors, decided to combine with the present company, and as they could not approve of this, the directors resigned. But although the original company disappeared in the new company, the property did not disappear, and it was about that property he should like to have some information. The directors of the original company left it in this condition—there were some contracts of greater or less value about to be completed; there was a valuable plant in London; a very valuable plant in Paris, value to the extent of several thousands of pounds; and there was over £27,000 cash at the bankers. There were no debts or liabilities worth mentioning; and, although the shareholders took the step unanimously of merging with the French company, they never anticipated that their property would disappear without some explanation being given. Although he had had no communication with the directors of the French company since 1882, yet it had come to his knowledge, indirectly, that this company was not altogether without the possibility of hope of rehabilitating itself to a certain extent in regard to the property now in France. The French laws were different to ours, and gave greater facilities to *bonâ fide* creditors. He would warn them not to take any steps to justify the French directors in a refusal to come over and give an explanation. He understood a committee was formed at the last meeting, and he would suggest that, supposing things did not go off satisfactorily on Wednesday, the committee be enlarged, so as to comprise the interests of the shareholders effectively, and that it should then investigate the affairs of the company in a very complete and thorough manner.

The Chairman announced that he had just received a letter from M. Cadiot, stating that, as he was attending the boat race, he could not be present at the meeting.

After some further discussion, during which it was intimated that the last quarter's rent for the offices of the company in London, amounting to £75, had not been paid,

Mr. Montague Turner moved the appointment of the following committee for the purposes of investigation:—Sir Charles Clifford, Messrs. Edward Ponsonby, W. Doyley, Harvey Rankin, Harcourt Turner, L. A. Solomon, Grenfell, and W. W. Duncan. These gentlemen were unanimously appointed, and it was understood that a meeting of the shareholders would take place after the directors' meeting, on Wednesday next, to discuss further proceedings.

The meeting then terminated.

Eastern Electric Light and Power Company, Limited.

AN adjourned meeting of this company was held at the City Terminus Hotel, Cannon Street, on Tuesday, when Mr. E. Noel, M.P., the Chairman, presided, and said that on the last occasion, owing to a severe cold from which he was suffering, he was not present, and the meeting was adjourned to see Mr. Bull, one of their shareholders, who had been lately at Bombay. As that gentleman only arrived on the previous day, and he (the chairman) had only been able to see him that morning, it was quite impossible for the board to lay before the shareholders the proposals which he thought they would be able to make. He would, therefore, simply move the further adjournment of the meeting to the 22nd inst., at 12 o'clock, when they would meet at their offices, 19, Great Winchester Street, and when Mr. Bull would have fully communicated to the board his views, and have given them full information as to the present state of things at Bombay. They would then be able to lay before them the reasons for or against the original proposal, and also as to what they might decide as to the future working of the company.

Mr. James Pender seconded the adjournment, which was agreed to, and the meeting dispersed.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The accounts for the half-year ended 31st December last show an available balance of £118,826. Out of this sum payment will be made on the 24th inst., free of income tax, of the usual dividend of 2s. 6d. per share, together with a bonus of 3s. per share, making, with the three interim dividends and the bonus of 1s. per share for the first half-year, a total payment of 7 per cent. for the year, against 6¼ per cent. for 1882. A balance of £50,076 will be carried to the reserve fund, thereby increasing that fund to £462,821.

The Direct United States Cable Company, Limited.—The directors recommend an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ending 31st of March, payable on the 16th of May. The half-yearly interest on the 6 per cent. debenture loan will be paid on and after the 15th inst. at the Consolidated Bank, Limited, Threadneedle Street, E.C., where coupons should be left for examination three clear days before applying for payment.

The Indo-European Telegraph Company.—The board of directors have determined, subject to audit, and after setting aside £5,000 to the reserve fund, to recommend the payment for the six months ending December 31st, 1883, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 10s. per share, both free of income tax, carrying forward £59 5s. 4d. to the next account. The dividend and bonus will be payable on and after May 1st next.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of this company, held on Friday, the 4th inst., it was resolved, (after placing the quarterly sum of £37,500 to the credit of the renewal fund) to declare an interim dividend for the quarter ending 31st March, 1884, of 12s. 6d. per cent. on the ordinary stock and 25s. per cent. on the preference stock, payable on the 1st May to the stockholders registered on the books of the company on the 31st March, 1884.

The Eastern Telegraph Company announce the payment on the 15th inst. of a dividend of 3s. per share on the preference shares, less income tax, for the quarter ending 31st of March, 1884, and an interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended 31st of December, 1883.

The Submarine Cables Trust.—The coupons, due on the 15th inst., will be paid on and after that date by Messrs. Glyn, Mills & Co., at 67, Lombard Street, E.C., between the hours of 10 a.m. and 2 p.m. The coupons must be left for examination three days previous to calling for payment.

TRAFFIC RECEIPTS.

The Great Northern Telegraph Company. The receipts in March, 1884, £21,920; from 1st January to 31st March, 1884, £60,600; corresponding months, 1883, £57,194; 1882, £54,369.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 4th, 1884, were £3,711, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st March are £3,490 as compared with £4,275 in the corresponding period of 1883.

NEW PATENTS—1884.

5825. "Primary electric batteries." E. P. CHAMISONOVITZ, G. BINSWANGER. Dated April 2.

5832. "Brushes of dynamo-electric machines." C. J. BEECHEY. Dated April 2.

5844. "Conduction and conversion or change of tension of electric currents and apparatus therefor." W. R. LAKE. (Communicated by L. Bollmann.) Dated April 2. (*Complete.*)

5846. "Electric telephones." A. F. ST. GEORGE. Dated April 2.

5849. "Secondary batteries." F. G. HOWARD, T. J. JONES. Dated April 2.

5878. "Armatures for dynamo-electric machines." W. FAIRWEATHER, W. ROSS. Dated April 3.

5884. "Process for producing, regulating, and distributing electric currents." L. A. V. PELLEGRIN. (Communicated by G. Carette.) Dated April 3.

5885. "Electric Lamp." L. A. V. PELLEGRIN. (Communicated by G. Carette.) Dated April 3.

5909. "Electrical incandescent lamp safety holder." A. WRIGHT, G. F. PHILPOT. Dated April 4.

5922. "Galvanic batteries and utilisation or regeneration of their bye products." J. RAPIEFF. Dated April 4.

5959. "Telephone transmitters." G. L. ANDERS. Dated April 4.

5964. "Electrical contact apparatus worked by passage of railway trains." E. TYER. Dated April 4.

5986. "Indicator for electric bells." C. W. STEWART. Dated April 5.

5987. "Electric watch alarm." C. W. STEWART. Dated April 5.

6013. "Mode of, and apparatus for, working the call signals in telephonic communication, permitting of a direct call between the subscribers." C. D. ABEL. (Communicated by La Société General des Telephones.) Dated April 5. (*Complete.*)

6023. "Terminals or binding posts of electrical apparatus." A. M. CLARK. (Communicated by L. de Combettes.) Dated April 5.

6049. "Regulating and distributing currents for dynamo-electric machines." H. J. ALLISON. "Communicated by W. Hochhausen.) Dated April 7.

6064. "Instruments for measuring electricity." L. B. MILLER. Dated April 7.

6068. "Secondary batteries." E. JONES. Dated April 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

3763. "Electric clocks." G. M. HEROTIZKY. Dated August 1. 6d. Relates to improvements in electric clocks which are driven by electric elements, and the objects of the improvements are first, to give automatically once every minute an impulse to the pendulum, and second, to regulate the function of the electric current by means of the swinging pendulum.

3782. "Transmitters for telephones." T. M. MORRISS. Dated August 2. 6d. Consists in the construction of a carbon shell transmitter, which is useful for telephonic purposes. The inventor makes a carbon shell in two parts placed together so as to form a hollow box, but with an insulating material separating the two portions, and he attaches conducting wires to each side of the shell. He puts into the shell granulated coke. Figs. 1 and 2 are the sections showing the hollow spherical form of the improved transmitter, the shell in fig. 2 being shown perforated; *a*, *a*, represent the two halves of a sphere, made of gas or other coke, and forming the hollow shell; *b*, represents the insulating material separating the hemispheres, *a*, *a*; *c*, *c*, are the terminal wires of the electrodes, and *d*, is the crushed coke placed

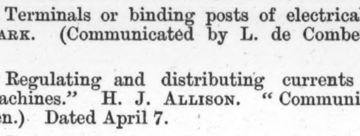


FIG. 1. FIG. 2.

within the shell, *a*, *a*. In fig. 2 both halves of the shell are shown perforated with fine holes, *e*, but it will be obvious that only one of the halves may be so perforated, or the shell may be made without perforations, as shown in fig. 1.

3915. "Incandescent electric lamps." G. F. REDFERN. (Communicated from abroad by A. Bernstein, of America.) Dated August 13. 6d. Relates to the manufacture of hollow carbon cylinders, which are with great advantage employed in electric incandescent lamps, as well as to the manner of uniting these carbons to the conducting wires.

5001. "Telegraph insulators. H. J. ALLISON. (Communicated from abroad by C. C. Hinsdale, of America.) Dated October 20. 6d. The said insulator is made of paper pulp, or pulp composed of vegetable fibre, and formed into the desired shape by moulding and compressing the said pulp by mechanical means or otherwise, whereby the said article is shaped for use, and which may be employed in place of, and in the same relation with telegraph lines as the ordinary glass or porcelain insulators.

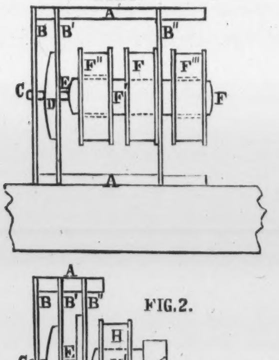
5447. "Telephones." C. A. JACKSON. Dated November 19. 6d. The objects of this invention are first to avoid the waste of time now consumed in waiting for an opportunity to call up any given subscriber on a telephonic circuit, or series of circuits, and to do away with the central office, so called, now extensively in use—secondly, in means for enabling a subscriber upon one line to communicate directly with a subscriber on another line, for instance, in a different city—and, thirdly, to enable two or more subscribers to communicate with different subscribers from the same instrument at the same time.

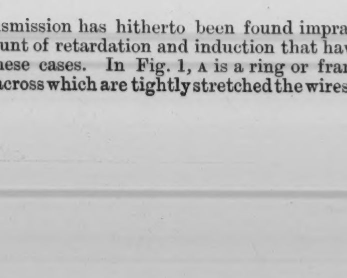
5453. "Housing and insulation of electrical wires beneath the surface of the ground." H. J. ALLISON. (Communicated from abroad by C. C. Gilman, of America.) Dated November 20. 6d. The inventor uses as the material for the construction of a protecting and insulating underground enclosure, terra cotta, composed of clay, and made porous or cellular by the means and in the manner described in British Letters Patent, No. 4634, dated October 22nd, 1881, namely by mixing with the clay in its preparation, one or two parts, by measure, of resinous wood saw dust, or equivalent comminuted combustible matter which is consumed in the burning of the ware, leaving it of a highly cellular structure, forming an earthenware that will receive and take up into itself mineral bitumen, so as to become saturated therewith, and thus be rendered impervious throughout to water, and also having a structure into, or through, which spikes or nails may be driven without fracturing it. This ware, when made of clay free from grit, is susceptible, after firing, also of being sawed or dressed with edge-tools into boards or planks, and other desired forms, and such forms fitted together to make close joints as wood may be wrought.

5717. "Electric low-water alarms for steam boilers, &c. A. M. CLARK. (Communicated from abroad by T. McKenna and H. Carley, both of America.) Dated December 12. 6d. The object of this invention is to provide an electric alarm apparatus, more especially intended for use as a low water indicator for steam boilers, in which apparatus mercury is used for completing the electric circuit when the alarm should be given.

4669. "Telephonic apparatus." E. GEORGE, F. A. POCOCK, J. S. MUIR and J. S. MUIR, junior. Dated October 2. 6d. The object of the invention is to provide efficient means for the transmission of telephonic signals over considerable lengths of wire, which transmission has hitherto been found impracticable owing to the amount of retardation and induction that have always been found in these cases. In Fig. 1, A is a ring or frame of metal or vulcanite, across which are tightly stretched the wires or strips, B, B^1, and B^{11}, which wires or strips are made of any metal or material that is incapable of inductive action. In the middle of the wire, B, is fixed a platinum head or pellet, C, which presses gently against the carbon disc or plate, D, which disc or plate is secured on the wire, B^1. On the back of the carbon disc or plate, D, at or near the centre thereof is fastened a short stud, E, of wood, vulcanite, ivory, metal, or other suitable material. On the wire, B^{11}, is fixed a helix of insulated wire, F, in the centre of which, and securely attached thereto, is an elongated core of soft iron, F^1, the end of which core, F^1, presses gently against the stud, E. Two other helices of insulated wire, F^{11}, and F^{111}, surround the core, F^1, one of the said helices being on either side of the helix, F, and the said helices, F^{11} and F^{111}, are rigidly fixed on the case or elsewhere, while the core F^1, can move freely within them. Thus, when the vibrations are set up in these helices which constitute the receiver by the variations of the current, the core, F^1, presses with greater or less force against the carbon disc or plate, D, through the mechanical or material intervention of the stud, E, and these said vibrations are thereby communicated to the transmitter, and by it forwarded. In Fig. 2, A is the ring or frame across which are stretched the wires, B, B^1, and B^{11}, as hereinbefore described. In the middle of the wire, B, is the pellet, C, which presses gently against the carbon disc or plate, D, the back of which disc or plate carries the stud, E, as hereinbefore described. The stud, E, presses gently against a plate or disc of soft iron, G, which plate or disc is secured to the wire B^{11}. Behind the plate or disc, G. and in close proximity thereto, is the helix of insulated wire, H, mounted on the core of soft iron, H^1, which core is attached to the permanent magnet, I, secured on the frame or elsewhere. The action in this form is similar to that hereinbefore described, namely, that the vibrations set up in the plate, G, are mechanically communicated to the transmitter through the intervention of the stud, E. A modification of this form consists in dispensing with the wire, B^{11}, and the stud, E, and connecting the plate, G, to the back of the carbon disc, D. In this case also the desired effect is produced by a material contact between the receiver and the transmitter or between parts of the same. In this form, as shown in Fig. 2, the inventors can also produce the aforesaid desired effect by induced magnetism. According to this method, they dispense with the stud, E, and instead thereof fix on the back of the disc or plate of carbon, D, another plate of soft iron, which faces the plate, G, before described. The magnetism induced in the plate, G, by the varying magnetism of the helix, H, will simultaneously produce corresponding varying magnetism in the plate on the back of the disc, D, causing the said disc, D, to vibrate.

FIG.I.





1884.

265. "Improvements in electric baths." MOSES HUMM. Dated January 1. 6d. By means of this invention a continuous current of electricity is caused to pass and be diffused through the whole system, and without the body being in absolute contact with any plate or wires or other conductor.

1158. "The covering of the core of submarine telegraph cables." H. G. BAKER. Dated January 10. 4d. Consists of a platted covering of tarred hemp yarn, which forms the cable, which covering being made without any turns, as in the ordinary rope, entirely protects the core of the cable, and also prevents any possibility of it becoming twisted or kinked, which twisting or kinking breaks the electric wire composing the core.

2405. "Galvanic battery." H. F. CLERK. Dated January 30. 4d. The inventor uses two similar electrodes preferably of carbon. For exciting the current he uses a solution of caustic soda and a solution of sulphuric acid, the acid being kept apart from the alkali by a porous cell, or some other suitable porous substance or material not readily acted upon by either an acid or an alkali.

2639. "Improved means for supporting and insulating electrical conductors. W. R. LAKE. (Communicated from abroad by J. W. Tringham, Canada.) Dated February 2. 4d. This invention relates to improved means for supporting and insulating wires for electrical purposes upon single or multiple-wire posts, whereby a more perfect insulation and protection from the weather is obtained, and loss of current by induction takes place than is now the case with the usual methods employed, and whereby there is less liability of displacement of the wire than heretofore.

2814. "Improvements in electric governors." ANDREW JAMIESON. Dated February 6. 6d. In carrying out the invention a disc of metal, and by preference of copper, made to rotate by the motor, is placed so that its outer part moves through a magnetic field or fields, induced by one or more electro-magnets, excited by means of coils of insulated conducting wire, which forms a shunt to the main circuit from the dynamo-electric machine. The same shunt circuit may be that which is used to excite, or to assist in exciting the field-magnets of the dynamo-electric machine; or it may be a separate or distinct shunt circuit used only for exciting the governor magnets. The governor disc is connected to the shaft or spindle, which carries and turns it by a volute spring, or other suitable spring, and in rotating it experiences resistance in passing between the poles, or pole-pieces of the governor magnets. When one or more of the lights are stopped, the strength of the current passing through the shunt circuit becomes increased, and by intensifying the magnetic field increases the resistance to the rotation of the disc, and this resistance is additionally increased because of an increase which simultaneously takes place in the speed of the motor. The increased resistance causes a relative movement between the disc and its shaft, and this movement is by suitable mechanism made to bring about the adjustment of the throttle valve, or equivalent part of the motor. When the action of one or more of the lights is renewed, the strength of current through the shunt circuit, and the rotatory velocity of the disc, become diminished, so as to lessen the resistance to the disc's rotation; and the volute spring then causes a reversed relative movement of the disc, which brings about the readjustment of the throttle valve, or equivalent part of the motor.

CORRESPONDENCE.

The Electric Light in the Observatory.

As I presume Mr. M. G. Towne is an astronomer, I should have thought that he would have taken in "The Observatory," a publication issued from Greenwich. If he had done so he would have seen an account, in two separate numbers, issued *two years ago*, of an adaptation of the electric light to the Observatory, precisely similar to that described in your last number, only with many more details. That adaptation I have continued ever since, and it is at this moment in full working order. The battery (only four *bichromate* cells) the moveable light (a 2½ candle Swan lamp); the switch to change the light into the eye-piece in order to illuminate the wires of the micrometer &c., and the regulation of that light by the depth the elements are sunk in the solution; all is there described much more fully than by Mr. Towne. "Palmam qui meruit ferat."

St. Vincent Beechey.

Hilgay Rectory, *April 5th*, 1884.

Domestic Electric Lighting.

Hilgay Rectory, Norfolk, is now completely lighted by the Electric light. A description and some account of the cost and working may not be uninteresting to your amateur readers. The engine is a one-horse nominal steam engine. The boiler, a vertical one, suited to it. The dynamo is a Gramme machine sufficient for sixty 20 C.P. lamps. Much larger, of course, than I require. But as I was fortunate enough to buy it secondhand, though as good as new, for one quarter of its original cost, and as I can get out of it as much as my engine can drive, it is far more economical than a smaller dynamo. It needs only 600 revolutions for all the lamps that I require. It is most solid and substantial and cannot get out of order. It *never sparks*, and so neither brushes nor commutator ever burn, and it never needs looking after all the time it is running, nor ever heats at all after its four hours run. I have three lamps in the drawing-room, three in the dining-room, one in my study, two in the hall and staircase, one in each of three bedrooms, one in the pantry, one in the kitchen, one in the back kitchen, two in my parish room, and one in the engine-room or workshop, in all eighteen lamps. I *can* use all these at once, but it requires the steam to be kept up to 60 lbs. in order to do so, and I never require them all. As a rule the drawing-room and dining-room are not both required at once, except with company, when I use both. The three bedroom lights are turned on and off like gas, to be used only when dressing &c., the two lights in the parish room are only required once or twice a week for an hour. Also all the single lamps have switch holders, so that they can be separately turned on or off as wanted. As a general rule I run twelve lamps, which number I can keep perfectly bright with the steam kept at 45 lbs on the inch. As I also got my engine secondhand and very cheap, the cost of the entire plant did not much exceed fifty pounds, I put up all the wires &c., myself. The lighting is a very complete success.

Now as to economy. It costs me in coals, and the lad who looks after engine and dynamo, 2s. 6d. a night. That is 2½d. for each lamp burning three or four hours. Say one penny per lamp per hour (an over estimate). In one sense this is far from economical. It is not dear if you are buying *light*, for each lamp is equal to twelve wax candles. But it is dear, because you are using and *must use*, more light than you want. You save nothing by running less than twelve lamps. It is not dear, if you live, as I do, in a village where there is no gas, and you hate paraffin, and you take into account all the cleaning and filling of lamps, wicks, glasses, and smells. And it is decidedly cheap if you have company, and want a nice bright, cheerful house, with cool, fresh rooms, and well lighted offices. I may just add that in the bedrooms the lamps are on brackets just over the looking glass, so that the ladies have plenty of light to see they are all right before they go down to dinner.

What is really the greatest drawback to the use of the electric light in domestic lighting is the want of accumulators; for as we do not like to keep our lad up after ten o'clock, we let him knock off about that time.

St. Vincent Beechey,
Hon. Canon of Manchester.

On the Action which takes place in Ring Armatures.

When the controversy, began in the ELECTRICAL REVIEW a short time since concerning the action of the Gramme ring, and the action and direction of the magnetic lines of force, I waited anxiously the result, because I thought some useful and valuable knowledge would come of the controversy. I can only say that I was disappointed, and so were others, because it simply ended in personal abuse, and an endeavour to largely advertise a machine as being superior to all others. With the editor's kind permission, I will describe, as well as I can, the means that has always cleared the difficulty, to my mind, as to the real action of the so-called Gramme ring.

I am one of those who hold that the wire in the under part of the ring is not idle, but equally as active as the wire upon the upper part of the ring, minus the cutting of the lines of force of the field magnet poles. I hold this view all the more forcibly because it is the result of actual practice in the every day construction of dynamo-electric machines. But there are certain conditions necessary to bring about this result in the best possible manner, and these conditions have only been found after years of laborious work, hard study, and repeated failures in the constructing of such machines.

I am glad to see that Prof. Silvanus Thompson has pretty well come to the conclusion that the Pacinotti form of ring is probably one of the best forms of ring armatures, because it is this form of ring that I have made for some considerable time, being led thereto from a consideration of theoretical principles.

These principles I will now endeavour to describe. *a*, in fig. 1, represents a bar magnet, D represents a bar of soft iron surrounded with a coil of insulated wire at its centre, the terminals of this wire coil, A, B, are attached to a galvanometer; when the bar magnet, *a*, approaches or touches the soft iron bar, D, the needle of the galvanometer becomes deflected, and when the bar-magnet, *a*, is withdrawn, the needle is again deflected, only this time in the opposite direction. The cause of this deflection of the galvanometer needle is due to a current of electricity being produced in the wire coil surrounding the iron bar, D. This current of electricity being itself produced by the inductive action of the iron bar, D, and this inductive action of the iron bar, D, is caused by the bar-magnet, *a*. We learn from this experiment three important points—first, that no parts of the wire are idle; second, that molecular change takes place in the bar, D; and thirdly, it is the principle of the so-called unipolar dynamo machine. In fig. 2 the bar, D, is bent like the letter U. If the wires, A, B, are attached to a galvanometer, and the bar-magnet, *a*, is made to touch or approach the end of one of the legs, exactly the same effect will take place as in fig. 1. But if we substitute the bar-magnet, *a*, with a powerful horse-shoe magnet, *c*, the result will be the same as with the bar-magnet, *a*, only the effect will be much more powerful.

Now let us see what bearing the above has upon dynamo-electric machines. The first illustration is fig. 4. E represents a section of the original Siemens armature, nearly surrounded with the poles of a magnet.

FIG.1.

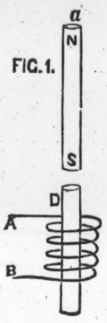


FIG.2.

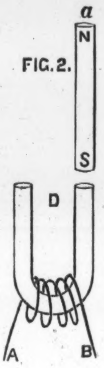


FIG.3.

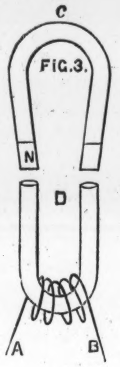
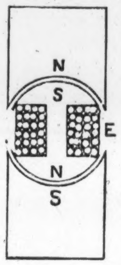


FIG.4.



What takes place. The iron coil of the armature upon which the wire is wound becomes a magnet by induction, an actual bar-magnet, as the iron core, D, did in fig. 1. The ends of the wire coil upon this armature are each taken to a separate metal ring; when the armature makes half a revolution, the pole marked N, changes and becomes S, and S becomes N, that a wave or current of electricity has been produced in the surrounding wire coil and a consequent molecular change in the iron of the core, when another half revolution is made the same action takes place, only this time the wave or current of electricity passes in the opposite direction.

The next illustration is fig. 5. I have often wondered whether Dr. Antonio Pacinotti had this design in his mind when his armature was devised. As will be seen, it is simply a number of Siemens' original armatures placed in a circle. If the spaces covered by the dotted lines were filled in, it would at once form the Pacinotti armature. It will be seen from this that if each space is filled up with insulated wire that it would form an eight-division compound ring of original Siemens armatures, one half of the ring forming a south pole, the other half a north pole by induction from the field-magnet. These poles become fully developed near the opening of the field-magnet. Exactly the same action takes place when this ring is moved an eighth of a revolution, as takes place in the armature, E, of fig. 4. A molecular change takes place in the iron ends between which are packed the coils of wire; the underneath part of this wire coil has not been idle in the eight-division ring, any more than it was in the Siemens armature of fig. 4, the wire being wound exactly at the right place, *i.e.*, the centre of the bar, and consequently receives the full inductive action of polar change, as well as cutting the lines of force emanating from the field-magnet poles direct in the outer half of the wire coils.

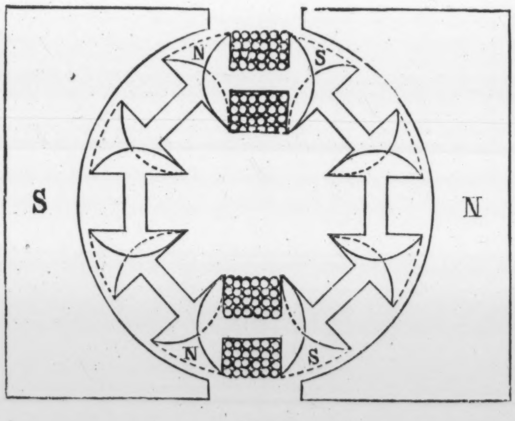


FIG. 5.

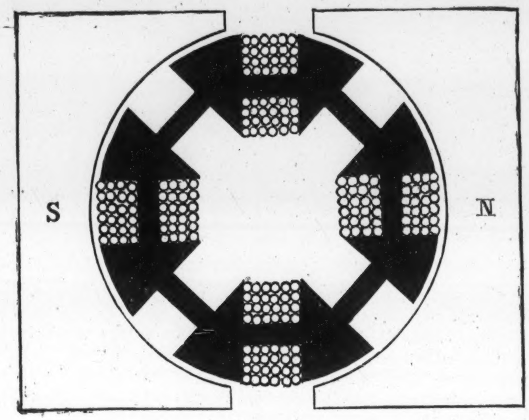


FIG. 6.

In fig. 6, the true Pacinotti armature is illustrated with four of its gaps filled with wire, and four gaps left unfilled. Here the exact actions take place as in fig. 5. It is a well known fact, and has been proved over and over again, that the greatest inductive effect of an iron bar is at its centre; such being a fact, it is quite impossible to prove that the underneath part of an iron ring surrounded with coils of wire is useless in producing current. It is equally active if the magnet cylinder is allowed to project about a quarter of an inch over the ends of the wire coils. Quite contrary to some of the diagrams and argument illustrated and published in the ELECTRICAL REVIEW recently, the lines of force *do* turn a curve and act upon the underneath part of the ring, providing that ring is kept well within the magnet polar extensions. Fig. 7 illustrates in section the Gramme ring, which centre ring is composed of iron, only it is kept further from the field-magnet poles than in the Pacinotti ring. Around this ring the lines of force are distributed equally. In the Paccinotti they are distributed unequally, forming points of concentration where the iron extensions of the armature project. But in principle, the same molecular changes take place in the iron ring as take place in the Pacinotti, the original Siemens, or in the simple illustration of fig. 1.

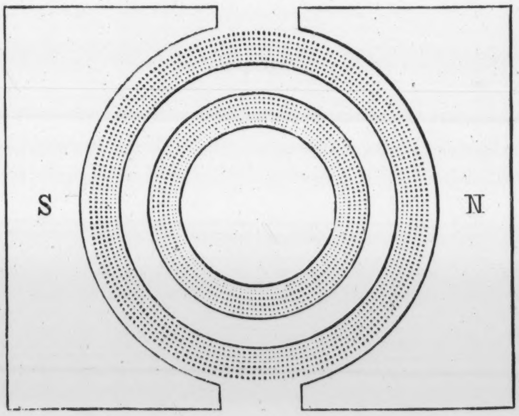


FIG.

A. J. Jarman.

London, *April 7th*, 1884.

PATERSON & COOPER,

ELECTRIC LIGHT & POWER & TELEPHONE ENGINEERS,

ST. PAUL'S WORKS—76, LITTLE BRITAIN, LONDON, E.C., AND
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